



*Aquaculture Department  
Tigbauan, Iloilo, Philippines*

*Better Life Through Aquaculture*

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**1991 REPORT OF SEAFDEC  
AQUACULTURE DEPARTMENT**

*Better Life Through Aquaculture:*

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The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in 1967. Its Member-Countries are Japan, Malaysia, the Philippines, Singapore, and Thailand.

Created to develop fishery potentials in the region in response to the global food crisis, SEAFDEC undertakes research on appropriate technologies, trains fisheries and aquaculture technicians, and collects, analyzes, and disseminates fisheries and aquaculture information. To pursue these objectives, the Center established three key departments - Marine Fisheries Training Department (Thailand), Marine Fisheries Research Department (Singapore), and the Aquaculture Department (Philippines). A fourth department, the Marine Fishery Resources Development and Management Department, was approved by the *Council of Directors* (SEAFDEC's policy-making body representing the Member Countries) at its 23rd Meeting in December 1990 for establishment in Malaysia.

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All photographs except that on p. 54 are by I. Tendencia.

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To promote and undertake aquaculture research relevant and appropriate for Southeast Asia;  
To develop human resources for aquaculture development in the region; and  
To disseminate and exchange information on aquaculture.

MANDATE OF THE SEAFDEC AQUACULTURE DEPARTMENT.



## OVERVIEW

**1** 991 marks the last year of the Aquaculture Department's three-year program based on ADSEA I (*Seminar-Workshop on Aquaculture Development in Southeast Asia*, 8-12 Sept 1987, Iloilo City, Philippines). ADSEA I then planned the 1989-1991 research and training activities of the Department. This *Report* notes achievements for 1991. It also contains the Department's programs for the next three years (1992-1994).

ADSEAII - including prospects for seafarming and searanching - was held 19-23 Aug 1991 in Iloilo City and its proposed three-year plan for aquaculture research and training was approved by the SEAFDEC Council at its Meeting in December.

The ADSEA seminar-workshops ensure that research and training are relevant and reactive to the economic realities of Southeast Asia. For a better life through aquaculture.

**1** 991 also saw the Department's continued growth as a research institution. Research on economically important food fishes in the region continued. Most of the research results are published in refereed journals to disseminate these to as wide an international audience as possible. Researchers are also formed into commodity teams to make research in each species coherent and unidirectional. Collaborations with international and national institutions are ongoing. Research is made more efficient with the operation of service laboratories which also assist fishfarmers.

The Department continues to train present aquaculture specialists with its regular training courses and future specialists with its practicum-internship trainings geared towards undergraduate students and out-of-school youth. It also continues to extend packaged technologies through its publications, extension activities, documentation services, and visitors' services.

All these research, training, and information activities are well supported by its administration and finance arms which provided the best work atmosphere and incentives to Department personnel.



## RESEARCH: Development of viable aquaculture technologies

The approved research program for 1991 includes no less than 13 culture species and six areas or disciplines:

Culture species - six species of marine finfishes (sea bass, grouper, snapper, mullet, rabbitfish, milkfish); three species of freshwater finfishes (tilapia, catfish, carp); three marine species of shrimps (giant tiger shrimp, white shrimps); one or a few species of bivalves (oyster primarily); one genus of seaweed (*Gracilaria*).

Disciplines - breeding (except for seaweed and tilapia); culture (sea bass, grouper, milkfish, white shrimps, seaweed, molluscs); feed development (sea bass, grouper, mullet, milkfish, tilapia, catfish, carp, giant tiger shrimp); fish health (sea bass, grouper, catfish, giant tiger shrimp); genetics (tilapia); stock assessment (giant tiger shrimp, molluscs, seaweed).

From these, specific research proposals were made by the senior research staff. The staff were also guided by a discussion organized by the Department on 1991 research activities which was attended by representatives of the academe, the government, and the private

sector. The discussion was aimed at refining the studies to be implemented, in consideration of the needs of the aquaculture industry.

Research ultimately develops viable aquaculture technologies, with research results its raw materials. That is, research results form the basis of the packaged technologies that will be disseminated later.

Accomplishments in research follow.

### **S**TUDIES ON SEA BASS (*LATES CALCARIFER*), GROUPER (*EPINEPHELUS SPP.*), AND SNAPPER (*LUTJANUS SP.*)

Following the priorities set during ADSEA I, research activities for sea bass were geared towards (1) intensification of induced breeding techniques, (2) verification of hatchery and nursery techniques, (3) development of practical diet, and (4) disease control.

For grouper: (1) development of induced breeding and seed production techniques, (2) improvement of nursery techniques, and (3) development of practical diet for the nursery phase.

For snapper: (1) identification of candidate species for breeding and (2) broodstock development.

Thirteen studies were conducted for sea bass, seven for grouper, and one for snapper. Of these 22 studies, 15% were completed; 85% will be continued in 1992.

Reported by MN Duray - commodity team leader; ACEmata, JT Fermin, LMaB Garcia, FJ Lacanilao, GFQuinitio, JD Toledo, RF Bombeo, DG Estenor, AC Fermin, FD Estepa, J Imayoshi, AR Castillo, MR Catacutan, RM Coloso, RF Agbayani, RM Cheong, E Rodriguez, NB Solis, N Yasunaga, S Shirahata - team members.

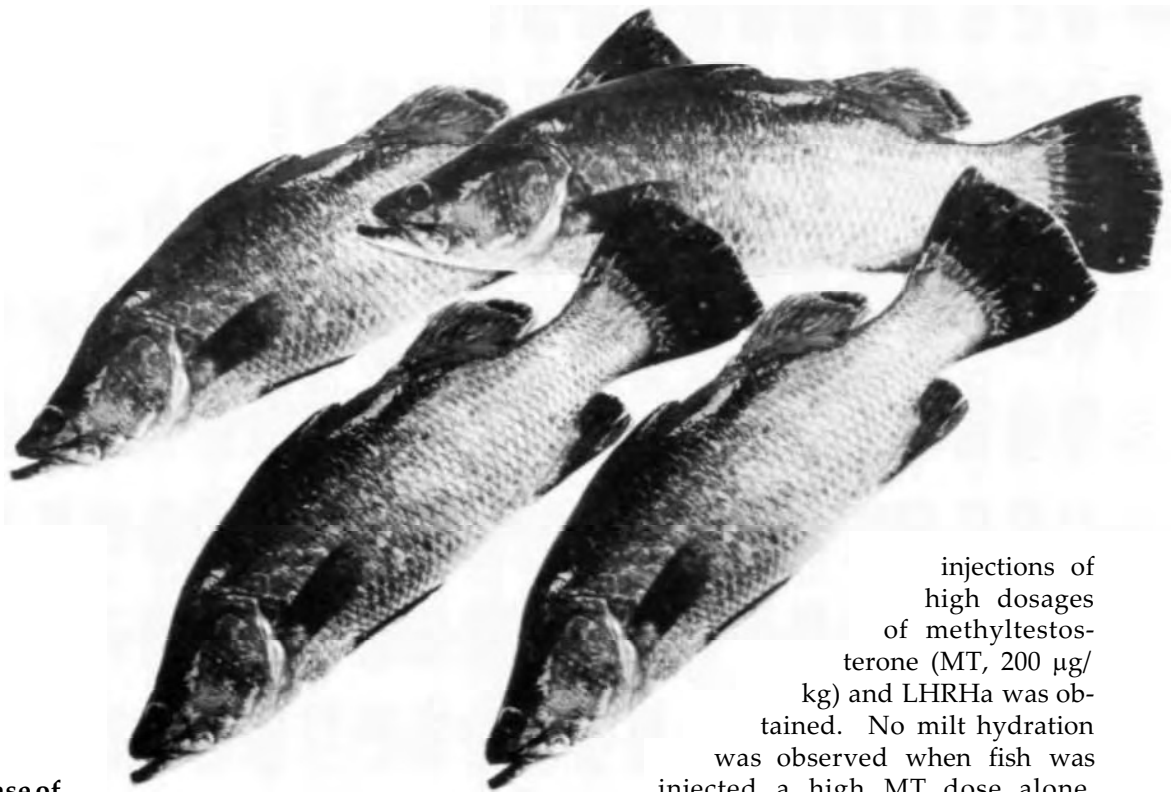
*The Department has three stations: Tigbauan Main Station (Tigbauan, Iloilo); Igang Marine Station (Guimaras Is., Iloilo); and the Binangonan Freshwater Station (Rizal) where studies on Laguna Lake aquaculture are also conducted (left photo).*



### Research studies

The following table summarizes the number of research studies conducted Jan-Dec, by species.

	Breeding	Nursery	Farming systems	Feed dev'l	Fish health	Total
Sea bass	4	6	-	3	-	13
Grouper	2	3	2	-	-	7
Snapper	-	-	1	-	-	1
Mullet	1	-	-	-	-	1
Milkfish	4	8	1	2	1	16
Red tilapia	2	-	-	-	-	2
Tilapia	1	-	3	-	-	4
Catfish	1	-	-	-	-	1
Bighead carp	1	-	-	-	-	1
Giant tiger shrimp	2	3	3	6	2	16
White shrimp	1	-	-	1	-	2
Molluscs	-	-	4	-	-	4
Seaweeds	-	-	6	-	-	6
Fish microbiology	-	-	-	-	3	3
Seafarming	-	-	4	-	-	4
Total	19	20	24	12	6	81



Sea bass,  
*Lates calcarifer*

- **Spawning response of sea bass to LHRHa stored under various conditions**

An injection of solubilized luteinizing hormone-releasing hormone analogue (LHRHa) stored for more than 90 days in a refrigerator (4-10°C) or for more than 30 days at room temperature (28-30°C) reduced the spawning response (0-25%) of mature female sea bass. Fish injected a solution of LHRHa which was previously frozen, subjected to alternate freezing and thawing, and exposed to sunlight or fish implanted a pelleted LHRHa which was stored at room temperature for 30-120 days had elevated spawning response levels (75-100%) similar to fish administered a fresh hormone preparation. The low spawning response of sea bass to injected LHRHa previously kept for 60 days at room temperature and 120 days in a refrigerator was related to bacterial growth in stored solutions. Injection or implantation of LHRHa did not generally influence the egg production capacity of sea bass.

- **Spermiation response of sea bass to LHRHa and methyltestosterone (Thesis Research)**

Sperm count and spermatocrit of sea bass were highly correlated ( $r=0.85$ ). Compared with saline-treated fish, milt volume and the number of spermatozoa increased but sperm count decreased (18%) 24 h after a single injection of a low (20 µg/kg/body weight) LHRHa dose. Further, a decrease in sperm count (31 %) or milt hydration was induced by a high (80 µg/kg) LHRHa dose at 12 h post-injection. A lower milt hydration (22%) response at 12 h and a highly variable response at 24 h after simultaneous

injections of high dosages of methyltestosterone (MT, 200 µg/kg) and LHRHa was obtained. No milt hydration was observed when fish was injected a high MT dose alone.

However, fertilization of spawned eggs occurred after six weekly injections of a low (100 µg/kg) MT dose with or without a resolving dose of LHRHa on the 6th injection.

When spontaneous milt release was successful, the fertilization capacity of LHRHa-treated males was highly variable (79 000-857 000 eggs/kg body weight); larval survival was inconsistent (0-90%). Less variable fertilization capacities (244 000-410 000 eggs/kg) were exhibited by males injected a low MT dose. Hatching (88-94%) and larval survival (48-51 %) rates were consistent.

- **Photoperiodic induction of off-season gonadal maturation of sea bass**

Female sea bass (mean body weight, 5.2 kg) kept under three experimental photoperiod regimes [8 h light (L): 16 h dark (D), 12L:12D, and 16L:8D] in 6-m dia. concrete tanks since Nov 1990 had mature oocytes (mean oocyte dia. >0.40 mm) throughout the spawning season (May-Nov). In Dec, mature oocytes were obtained from all fish kept at 8L:16D and 12L:12D. However, no oocytes were biopsied from fish kept at 16L:8D.

- **Nursery of sea bass in illuminated cages. II. Different size groups and feeding regimes**

Sea bass fry having initial total lengths (TL) of 1.1 (Group 1), 1.7 (Group 2), and 2.1 cm (Group 3) were stocked in batches at 1500,700, and 300/m<sup>3</sup>, respectively, in illuminated cages. Fish were reared without supplemental feeding. After 42 days of rear-

ing, fish in Groups 2 and 3 reached the desired size of 6.2 and 6.1 cm TL and were significantly larger than those in Group 1. Survival was generally low and ranged <2-20%.

- **Nursery rearing of sea bass in ponds. I. Food and feeding**

Forty-two day old sea bass fry (mean TL, 2.2 cm; mean BW, 0.13 g) were stocked in 9 units 1x3x1.5 m net cages in a pond at 1000 ind/cage. These were fed formulated diet (Diet 1) daily, trash fish (Diet 2) daily, or their combination (Diet 3) on alternate days. After 5 wk, mean TL and BW of Diet 1-(66.6 cm; 3.8 g) and Diet 3-fed (61.0 cm; 3.6 g) fish were significantly higher than Diet 2-fed fish (3.5 cm; 0.7 g). Mean feed conversion ratio among the Diet 2-fed fish (11.9) was higher than the Diet 1- (1.5) and Diet 3-fed (2.2) fish. Mean weekly survival of Diet 1-fed fish (68%) was markedly higher than Diet 3- (58%) but not Diet 2-fed fish (61%). There were no significant differences in the mean condition factor among the three groups.

- **Nutrition and feed development for sea bass. I. Requirement for sulfur amino acids by juveniles**

Sea bass juveniles (mean BW, 16.5 g) were fed semi-purified diets containing Peruvian fish meal, squid meal, soybean meal, amino acid mixture, and graded levels of L-methionine (1.38-2.8% dietary protein) for 12 wk. The diets also contained a basal amount of cystine (0.69% dietary protein). Best growth was obtained in fish fed the diet containing 2.40% L-methionine. Survival (97-100%) was high over the rearing period. Fish samples were analyzed for carcass proximate analysis, lipid and protein content (liver and muscle), and plasma amino acids.

- **Practical diet development for sea bass: Dietary protein and energy ratio**

Sea bass fry (mean BW, 1.38 g) were fed practical diets for 54 days. The diets were composed of three protein levels (35, 42.5, 50%), each with three lipid levels (5, 10, and 15%). Carbohydrate level was constant. Survival rates in all treatments (range, 93-100%) were not significantly different. However, growth (2783-3014%) and specific growth rate (6.2-6.4) were significantly higher among fish fed the diets containing 50% protein at 10% and 15% lipid compared to other treatments except those fish fed 42.5% protein at 10% lipid. Fish fed a diet containing 35% protein at 5% lipid showed poorest growth. Protein efficiency ratio was significantly higher among fish fed a diet with 35% protein at 10 or 15% lipid.

**In progress:**

- Spawning of sea bass by oral administration of LHRHa
- Verification studies of hatchery production of sea bass
- Use of live and dried *Artemia* biomass as feed for sea bass fry in nursery tanks
- Rearing of sea bass fry in tanks at different stocking densities and salinity
- Use of pre-adult *Artemia* as feed for sea bass fry
- Nutrition and feed development for sea bass: Quantitative essential amino acid and fatty acid requirements of juveniles. II. Requirements for lysine, arginine, and histidine

**Grouper,**  
*Epinephelus sp.*

- **Broodstock development of *Epinephelus sp.* and *Lutjanus sp.* for seed production**

Spontaneous spawning by *E. suillus* broodstock in concrete tanks occurred 6-14 times monthly from Jan to Dec. Daily egg collection varied from 9500 to 2 million. Fertilization and hatching rates ranged from 23 to 94% and 0 to 87%, respectively.

One spermiating male and one maturing female were noted in Sept among the 12 red snapper broodstock maintained in concrete tanks. Similarly, 3 of 5 fish kept in floating net cages had mature oocytes in Sept.

- **Survey of *Epinephelus spp.* fry in the northeastern coast of Panay Island**

*E. suillus* (*E. malabaricus*, *E. salmoides*, or *E. tauvina* as previously reported) were the dominant grouper fry found along channels of inshore waters in northern Panay. *E. megachir* fry were found in rocky intertidal areas. Fry started to appear in July until Nov, although plankton samples did not yield any larvae. Peak occurrences of 20 cm (standard length) *E. suillus* fry in Aug and of two distinct size groups of this species in Nov and Dec were observed. A 500 g *E. suillus* caught in the study area was not sexually mature. Crustaceans (small crabs and shrimps) and fish appear to be the preferred food of *E. suillus* and *E. megachir*.

**In progress:**

- Egg quality evaluation of *Epinephelus suillus* (Thesis Research)
- Development of larval rearing techniques for the grouper, *E. suillus*: Food and feeding
- Biological studies on the seed production of grou-



per, *E. suillus*. I. Effect of light intensity and food coloration on the growth and survival of larvae

- Biological studies on the seed production of grouper, *E. suillus*. II. Comparison and importance of dietary value of live and artificial food
- Grouper (*Epinephelus sp.*) culture in ponds given artificial diets

**Snapper,**  
*Lutjanus spp.*

- **Species identification of snapper (Genus *Lutjanus*) in Panay Island**

Thirteen species of lutjanids have been identified: *Lutjanus argentimaculatus*, *L. bouton*, *L. caponotatus*, *L. decussatus*, *L. fulviflamma*, *L. fulvus*, *L. gibbus*, *L. lutjanus*, *L. suillus*, *L. monostigma*, *L. quinquelineatus*, *L. rivulatus*, and *L. vitta*. Incidence of snapper was year-round with highest number of species occurring in May and June. Most abundant and commonly observed were *L. vitta*, *L. gibbus*, and *L. argentimaculatus*.

# **S** TUDIES ON MILKFISH (*CHANOS CHANOS*), MULLET (*MUGIL CEPHALUS*), AND RABBITFISH (*SIGANUS GUTTATUS*)

The goals of the milkfish-mullet-rabbitfish commodity team are:

1. Increase egg production and enhance egg and larval quality;
2. Develop mass fry production techniques; and
3. Formulate least-cost practical diets, as well as supplemental feed for grow-out.

Toward these ends, 16 studies were conducted on milkfish and a lone study on mullet (none on rabbitfish).

Highlights of the 1991 studies:

1. Attempts to prolong or accelerate gonadal development of milkfish achieved limited success.
2. Spontaneous spawnings were observed in milkfish given diets with low or high lipid levels at half or full ration.
3. Microparticulate diets containing highly unsaturated fatty acids ini-

tially proved successful as alternative feeds for milkfish larvae.

4. Ingestion and satiation rates of milkfish larvae and digestion time were determined.

5. Successful milkfish larval rearing runs were consistently observed at the latter half of the spawning season.

6. Physiological studies conducted included metabolism and recruitment mechanism of milkfish larvae along the shoreline.

7. Dietary essential amino acid requirement of milkfish for growth is now fully known.

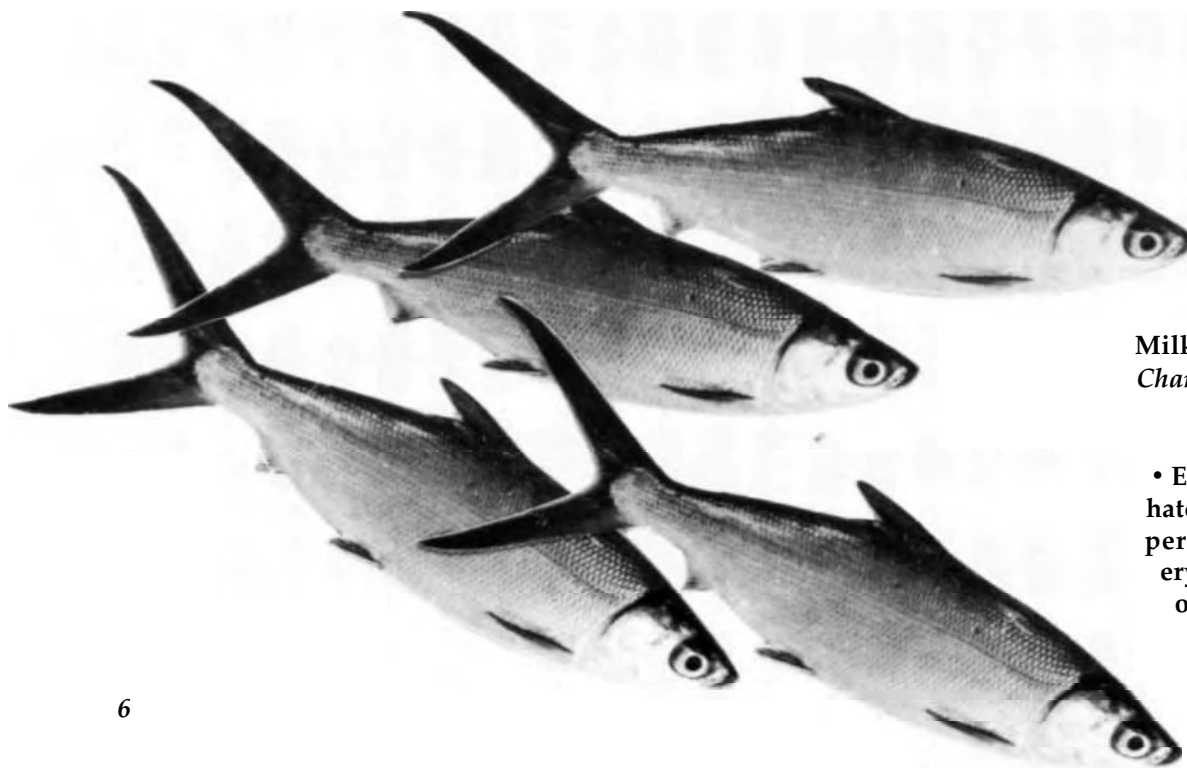
8. A method to determine *in vitro* protein digestibility of protein sources was found feasible.

9. Initial steps to formulate a suitable supplement diet for grow-out of milkfish were undertaken.

10. A vaccine using *Aeromonas hydrophila* failed to provide protective immunity to milkfish.

11. Spontaneous maturation of mullet in cages was obtained in Oct, the natural spawning season. However, spontaneous spawning has not yet been observed.

Reported by AC Emata - commodity team leader; CL Marte, CF Quinitio, LMaB Garcia, MN Duray, K Schroeder, NSSumagaysay, RM Coloso, IG Borlongan, GD Lio-Po - team members.



**Milkfish,**  
*Chanos chanos*

- Evaluation of milkfish hatchery technology and performance of hatchery-reared fry in grow-out culture

The milkfish hatchery operation of

4 private shrimp hatchery cooperators has largely been exploratory. From 10.9 million milkfish eggs disposed of, about 160 000 of 20- to 24-day old fry (12-24 mm) were produced from 6 of 14 larval rearing runs. Although travel time from Igang, Guimaras Is., Iloilo to hatcheries in Aklan and Iloilo took 4-7 h, survival rates of transported eggs were high (60-98%). Eggs were stocked at various densities (8-450 eggs/l) in containers of different dimensions (circular, rectangular) and types (concrete, fiberglass).

Hatching rates were variable (3-91%) and the occurrence of morphological deformities (e.g., "curled" larvae), although low (0.2-5%), and incomplete hatching were noted. Modifications of the SEAFDEC/AQD larval rearing scheme were made such as the introduction of microparticulate diets (BP, Riken) and antibiotics. Mass mortalities were common among 4- to 5-day old larvae. Harvested fry were either sold to brokers or stocked in nursery ponds.

- **Hormonal induction of off-season maturation of milkfish**

Nine-year old milkfish given estradiol-17 $\beta$  (E<sub>2</sub>) implants alone for a year spontaneously matured earlier than those fish given E<sub>2</sub> with LHRHa, LHRHa alone, or cholesterol pellets only (control). When kept in a 200-t concrete tank, this stock spontaneously spawned 53 times from 25 Apr to 31 Oct. Twelve million eggs (mean viability, 80.6 $\pm$ 4.4%) were collected. Another stock of unimplanted fish of the same age kept in a separate tank also spawned naturally. However, this stock spawned 8 wk later and 9.5 million eggs were collected from 19 spawnings.

- **Influence of broodstock ration size and cod liver oil supplementation on quality of spawned eggs and larvae of milkfish**

Thirty-seven to 39 6-year old milkfish broodstock were distributed in 4 units 10-m dia. cages and fed a SEAFDEC-formulated diet (36% protein) with low (6%) or high (10%) lipid at full (4%) or half (2%) ration. Few spawnings were observed during the breeding season.

- **Metabolic energy requirements of selected finfish larvae (milkfish, sea bass, siganid, grouper)**

Growth of newly hatched milkfish larvae was rapid during the first 24 h and became stable in the next 48 h after hatching. Thereafter, a marked decline in growth was observed on day 4, which coincided with the time of complete yolk resorption. Likewise, survival declined until day 3, increased on day 4 (24.7%), and reached 0.03% on day 5. Body weight continued to decline from day 0 to day 5, reaching the lowest point on day 4.

- **Determination of the maintenance ration of varying sizes of milkfish at different rearing temperatures**

In the first run, three size groups of milkfish juveniles (20-50, 50-150, and 150-250 g) were fed an experimental diet (40-42% crude protein) at four feeding rations (1.25, 2.5, 4.5, and 6 g kg<sup>-0.8</sup>). Body weight was measured every 2 wk and feeding ration was adjusted accordingly. After 6 wk, the maintenance ration was estimated to be 5.2, 4.7, and 4.9 g kg<sup>-0.8</sup> for fish with body mass of 20-50, 50-150, and 150-250 g, respectively. Water temperature ranged 24.5 - 27°C. The second run showed that the maintenance ration of 40-100, 100-200, and 200-400 g fish at 27-28°C was 3.9, 4.2, and 5.3 g kg<sup>-0.8</sup>, respectively.

- **Feeding biology of milkfish larvae: Feeding pattern, digestion, and satiation time**

Nine-day old milkfish larvae digested rotifer (*Brachionus*) in 4 h. The rotifer was digested by 18-day old larvae in 45 h. Satiation time was 1-2 h. Although ingestion rates were relatively high at a low feeding level of *Brachionus* (<10 ind/ml), 14-day old larvae grew bigger when fed a higher concentration of the rotifer (20 ind/ml).

- **Studies on the oxygen consumption of milkfish with different body mass at different rearing temperatures**

Oxygen consumption of milkfish fingerlings (20-50 g body mass) at ambient water temperature (26-28°C) was measured over a 48-h period. Standard metabolic rate, routine metabolic rate, and scope for spontaneous activity were 138.3, 232.9, and 235.2 mg O<sub>2</sub>h<sup>-1</sup> kg<sup>-0.8</sup>, respectively. Fish consumed more O<sub>2</sub> during the day than at night.

- **Verification of the larval rearing technique for milkfish developed at SEAFDEC**

Milkfish larvae hatched from eggs spawned by tank- or cage-reared broodstock were reared in 5-t concrete or 10-t canvas tanks. From 34 rearing trials, 1.42 million fry were produced. Survival rates ranged 7.3-65.3% with mean harvest density of 8 fry/l after 21 or 24 days of rearing.

Verification runs in a private hatchery had a 61% survival rate and 9 fry/l harvest density when eggs were transported and hatched in the same hatchery. However, when hatched larvae were transported from another hatchery, only 11.7% survival was attained. Initial stocking density varied 6-32 larvae/l.

- **Mechanisms of recruitment and survival of milkfish larvae in coastal waters. II. Experiments on irreversible starvation (Thesis Research)**

Minimum prey density of wild milkfish larvae fed rotifer was 50-100 ind/l. However, the density of zooplankton collected from the intertidal zone was only 3-20 ind/l, suggesting that milkfish larvae prey on a very limited amount of food compared to their minimal intake.

Wild larvae had relatively higher starvation tolerance when the catch-per-unit effort (CPUE) was high. CPUE was high during new and full moon in 1991 although this was not observed last year.

- **Alternative feeding and rearing schemes for milkfish larvae**

In a series of experiments to determine whether supplementation with feed containing high levels of highly unsaturated fatty acids (HUFA) would improve growth or survival of milkfish larvae, the following results were obtained: (1) day 15 larvae fed the rotifer *Brachionus* plus an artificial diet [NOSAN-R1 (MBD1)] were significantly bigger than those reared on rotifer or fed MBD1 alone; (2) survival rate of day 21 larvae reared on rotifer+MBD1 was generally higher compared to those reared solely on live food or artificial feeds; (3) there was no significant difference in growth of larvae reared on 10 rotifer/ml with or without MBD1 and those reared on 5 rotifer/ml + MBD1, suggesting that density of the rotifer may be reduced by half.

- **Development of supplemental diet for milkfish. II. Growth and food consumption during dry and wet seasons**

During the wet season, milkfish given feed (35% protein) grew from 23.8 to 192.4 g and consumed daily 4.73 -23.86 kcal gross energy and 0.23 - 2.12 g protein. Growth rate and energy intake were not significantly different from fish fed a lower quality feed (rice bran, 25% protein). After 4 months of culture, fish dependent on natural food alone had significantly lower growth rate (34.2-77.5 g), energy intake (3.18-3.95 kcal), and protein intake (0.16-0.28 g) compared to fish fed artificial diets. Differences in energy and protein intakes provide an estimate of the amount of energy and protein that should be provided by a supplementary feed.

- **Requirements of milkfish juveniles for essential amino acids**

Feeding experiments were conducted using amino acid test diets (40-45% crude protein) to determine the quantitative requirements of milkfish juveniles for essential amino acids. Optimum requirement levels of milkfish expressed as a percentage of dry diet are: arginine, 2.1%; histidine, 0.8%; threonine, 1.8%; isoleucine, 1.8%; leucine, 2.3%; valine, 1.6%; phenylalanine, 1.9% at tyrosine level of 0.45% and 1.33% at tyrosine level of 1.2%. When expressed as a percentage of dietary protein, the requirements are: arginine, 5.25%; histidine, 2.0%; threonine, 4.88%; isoleucine, 4.0%; leucine, 5.11 %; valine, 3.55%; phenylalanine, 4.22% at tyrosine level of 1.00% and 2.80% at tyrosine level of 2.67%. The replacement value of tyrosine for phenylalanine was estimated at 46%.

- ***In vitro* determination of protein digestibility in milkfish (Thesis Research)**

No significant interaction between diet and salinity for weight gain, specific growth rate (SGR), and protein efficiency ratio (PER) was observed, although the main effects of salinity and diet were significant. Water content of fish carcass was negatively correlated with SGR ( $r=-0.857$ ). In all salinities tested, the highest and lowest protein digestibilities was observed for mungbean- and fish meal-containing diet, respectively, which correlated well with growth and PER. Although the *in vitro* protein di-

gestibility of shrimp head meal-containing diet was higher compared with *kangkong*-containing diet, milkfish growth and PER were higher in the latter. Adaptation effect concerning protein digestibility was observed for the diets containing vegetable protein sources. The pH optimum of milkfish pepsin was about 1.5.

- **Prevention of *Aeromonas hydrophila* infection in milkfish by vaccination**

Flagellar, somatic, and crude lipopolysaccharide antigens from a strain of *Aeromonas hydrophila* were used in an immersion vaccination experiment with milkfish fingerlings. A booster dose was given 14 days after primary vaccination. Immune response to the bacterin exposure was measured 14, 21, and 28 days post-primary vaccination and 14 days after the booster vaccine administration. The bacterin preparations did not elicit a protective immune response in the test fish. Antibody titers will be subsequently determined.

**In progress:**

- Photoperiodic effects on gonadal development of milkfish
- Measurement of critical oxygen tension of different body mass groups of milkfish at different rearing temperatures

**Mullet,  
*Mugil cephalus***

- **Mullet broodstock development for fish propagation**

Only 2 of 6 wild adult mullet caught from Jan to Mar survived. The number of maturing and mature wild mullet reared in a 6-m dia. cage decreased during this period and were all sexually immature in May. Mature females but not males were sampled in Oct. To date, no spontaneous spawnings of mullet in a *hapa-lined* cage have been observed.

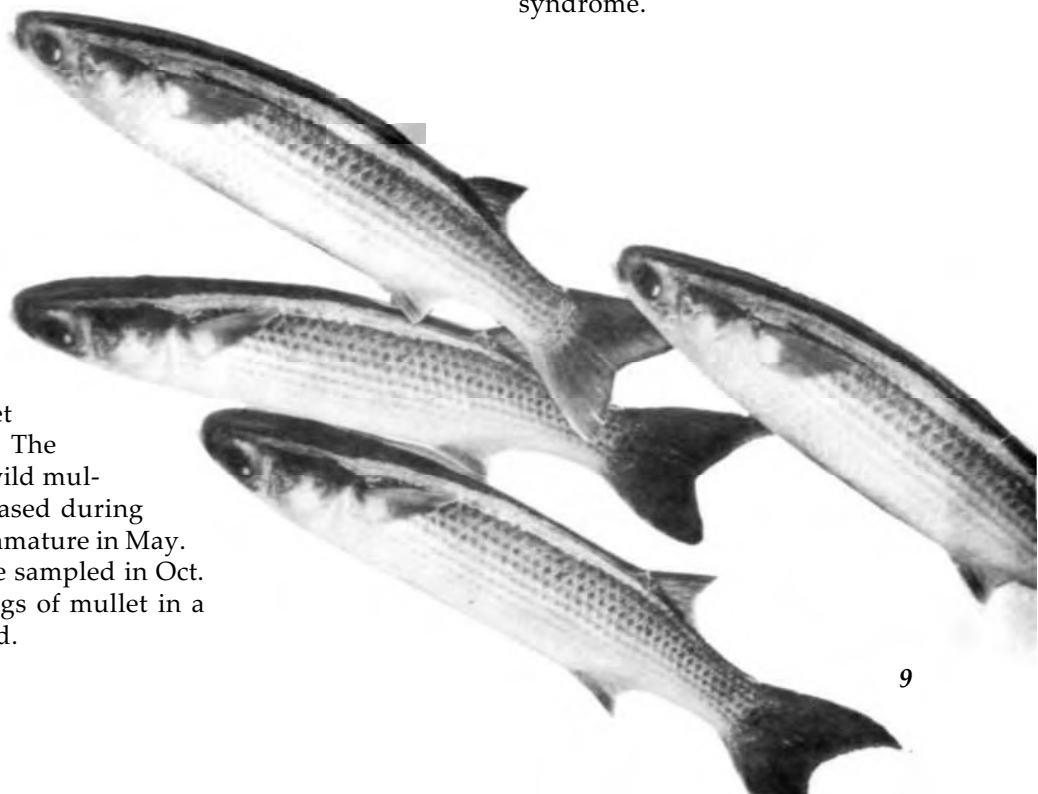
**S** TUDIES ON TILAPIA (*OREOCHROMIS NILOTICUS* AND RED TILAPIA) INCLUDING GENETICS, CATFISH (*CLARIAS MACROCEPHALUS*), AND BIG-HEAD CARP (*ARISTICHTHYS NOBILIS*)

Carp, tilapia, and catfish are important food fishes for many Filipinos. In 1990, the Philippines produced over 76 000 metric tons of tilapia from aquaculture, making the country the world's largest grower. Unlike other species, tilapia and carp feed low on the food chain; they cost cheaper (P55-70/kg) in Metro Manila and outlying provinces. Catfish is an indigenous carnivore which is getting scarce in its natural habitat. So, the following research studies were lined up in 1991:

Carp: broodstock and feeding management; refinements of hatchery and nursery techniques; and development of practical diets.

Tilapia: genetics and field testing of practical diets.

Catfish: refinement of induced breeding and seed production techniques; development of practical diets for broodstock and larvae; and catfish diseases, particularly the epizootic ulcerative syndrome.







Considering the low supply of experimental fish and problems on water quality in Laguna Lake, research studies were concentrated on the major constraint of tilapia and carp culture - mass production of fry in hatcheries. However, only genetic studies were conducted. For catfish, two trials on spawning at the peak and end of the natural spawning season were made.

Fish genetics research were focused on tilapia, red tilapia, and bighead carp. For tilapia, studies were on developing procedures for strain comparison and evaluation in different grow-out systems. Other studies were focused on heavy metal tolerance and uptake of different strains of *T. nilotica*. In line with developing a procedure for strain comparison and evaluation, red tilapia is being developed as a reference strain to be used as an internal control in comparison procedures. Also, a red tilapia study was aimed at developing an improved strain by introgressive hybridization and a series of selection and backcrossing. For bighead carp, a study was conducted on broodstock/breeding management to determine whether management schemes used by farmers caused the reported decline in the growth of bighead carp in Laguna Lake.

Reported by CB Santiago - commodity team leader (carp-catfish-tilapia); JT Fermin, AC Gonzal, MLA Aralar, AE Santiago - team members.

With ZU Basiao - team leader (fish genetics); MRR Eguia, CT Villegas, AE Santiago - team members.

## Tilapia

- **Development of a genetically stable reference population of red tilapia**

Production of inbred fish (by conventional sib-mating) from each of two strains of red tilapia has been completed and were subsequently outcrossed. Progenies produced are being tested as reference fish in a strain comparison experiment. Preliminary observations show that fish from the new reference line grew and survived better than the mass-spawned reference fish used in a previous study.

- **Development of a high-yield red tilapia strain through introgressive hybridization**

Around 500 F<sub>2</sub> red tilapia fingerlings which will be used for selection and backcrossing are presently being maintained in 3 x 3 x 1 m *hapa* net cages in Laguna Lake.

- **Practical methodology for genetic strain evaluation of tilapia in small-to-medium sized experimental facilities** (Thesis Research)

Sixty to 70% of tagged fish stocked in six rice paddies were recovered; recovery from commercial fish ponds was low. Circulus spacing as an estimate of recent growth in fish is efficient in comparing growth of different tilapia strains in a population consisting of mixed-age classes.

- **Evaluation of resistance of tilapia strains to heavy metal stress**

Preliminary studies using mass-spawned NIFI (National Inland Fisheries Institute, Thailand) and CLSU (Central Luzon State Univ., Nueva Ecija, Philippines) strains of tilapia showed that the NIFI strain had significantly higher survival rates than the CLSU strain after exposure to heavy metal mixtures con-

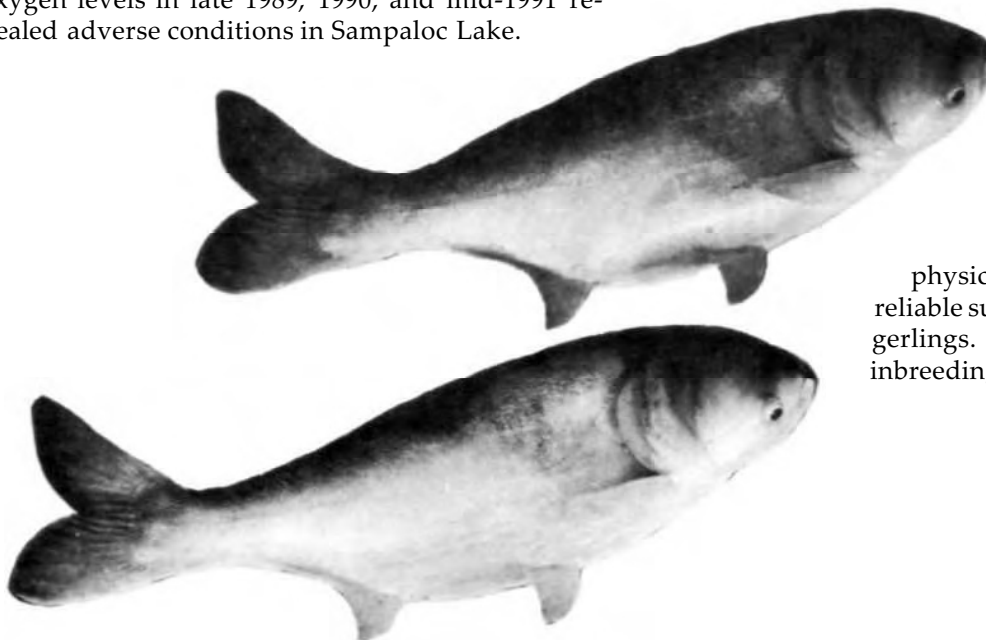
taining 5 ppm Zn, 0.5 ppm Cd, and 0.02 ppm Hg. However, survival of the two strains did not significantly vary after exposure to lower heavy metal concentrations (1 ppm Zn, 0.1 ppm Cd, and 0.01 ppm Hg).

- **Effects of exposure to sublethal heavy metal mixtures on two generations of two Nile tilapia strains**

Fingerlings of NIF1 and CLSU strains of tilapia were exposed to 1 ppm Zn, 0.1 ppm Cd, and 0.01 ppm Hg for 60 days and then transferred to *hapa* cages in the lake. Survival rate was 75%. No significant differences in the growth and survival of the two strains were detected among treatment groups.

- **Performance evaluation of two tilapia strains in two lake environments**

Farmers who cultured tilapia in cages which occupy 28 ha of the 104 ha crater lake, Sampaloc Lake, Laguna shifted to intensive feeding method in 1986. This practice resulted in excess commercial feed being the primary source of allochthonous organic matter in the lake. At three croppings annually, 5250 t of feed are given to tilapia; in 1988, cage operators began experiencing severe fishkills, resulting in millions of pesos lost. Data on temperature vis-a-vis dissolved oxygen levels in late 1989, 1990, and mid-1991 revealed adverse conditions in Sampaloc Lake.



**Catfish,**  
*Clarias macrocephalus*

- **Spawning catfish at different times during the annual reproductive cycle**

Catfish (body weight, 144-257 g) were induced to spawn during the peak (Aug) and end (Nov) of the natural breeding season. All fish ovulated and stripped of eggs 16 h after a single intramuscular injection of 0.05 µg LHRHa + 1 µg pimozide/g body weight. Egg production ranged 85-124 eggs/g. Fertilization and hatching rates of eggs from hormone-induced fish were 80-99% and 9-62%, respectively. The number of viable larvae upon yolk resorption was 2-43 larvae/g body weight of spawner (337-9289 larvae/fish).

**Bighead carp,**  
*Aristichthys nobilis*

- **Broodstock and breeding management of bighead carp in hatcheries around Laguna de Bay**

Carp hatchery operation around Laguna de Bay declined by 58% due to slow growth, physical abnormalities, and unreliable supply of quality fry and fingerlings. These are possibly due to inbreeding of parent fish.

# S

## TUDIES ON GIANT TIGER SHRIMP (*PE- NAEUS MONODON*) AND WHITE SHRIMPS (*P. INDICUS* AND *P. MER- GUIENSIS*)

The 1991 program of activities for crustaceans is as follows: (1) development of captive broodstock - basic studies on the male and female reproductive systems; (2) refinement of culture techniques - improvement of feeds for grow-out, amino acid requirement, quality assessment, and feed binders and additives; (3) studies on disease agents - transfer mechanisms of luminous bacteria (*V. harveyi*).

Most of the 16 studies conducted for *P. monodon* were on the improvement and quality assessment of feeds for grow-out culture. Studies on white shrimps were not conducted because no test animals were available.

Reported by FD Parado-Estapa - commodity team leader; ET Qunitio, CT Villegas, MR de la Peña, S Shirahata, GPB Samonte, NB Solis, AT Triño, IB Tuburan, MN Bautista, PS Eusebio, NV Golez, OM Millamena, VD Peñaflores, PF Subosa, ER Cruz-Lacierda, CL Pitogo, N Yasunaga - team members.



**Giant tiger shrimp,**  
*Penaeus monodon*

- **Histological characterization of giant tiger shrimp testes**

Small shrimps (< 1 g) had undifferentiated gonads. Testes of bigger shrimps (> 3 g) were more developed and showed early signs of spermatogenesis. Shrimps weighing 24 g (33-mm carapace length) had a fused petasma and translucent gonad. The vas deferens has two distinct lumen separated by an arc-shaped septum extending longitudinally.

Testes of cultured shrimps (> 20 g) were observed to be at various stages of spermatogenesis. The sperm mass was contained in the vas deferens, ampoule, or in both structures. Compared with wild shrimps, spermatozoa of cultured shrimps were smaller and had short or no spikes at all.

- **Hormonal changes during vitellogenesis in giant tiger shrimp**

Vitellogenin was localized in the ovary of giant

tiger shrimp by an immunoperoxidase staining method. Vitellogenin levels in the hemolymph increased as ovarian development progressed but it decreased after spawning. A similar trend was observed in estradiol levels in the hemolymph and in the ovaries. Although estradiol in the hemolymph began to decrease before spawning, estradiol levels in the ovaries decreased only after spawning.

Germinal tissues which later developed into the abdominal lobes of the ovary were observed among juvenile shrimps [14.9-19.8 mm carapace length (CL); 2.9-3.6 g]. Intense mitotic activity and primary oocytes were visible in the gonads of shrimps with 22.8-27.3 mm CL and 7.7-20.8 g body weight (BW). Vitellogenic oocytes were observed among bigger shrimps (34-45 mm CL; 25-50 g BW). Spawning occurred among 36-49 g females after 10 months in captivity, although eggs were not fertilized. Regardless of the ovarian stage of development, females can be impregnated with spermatophores when the thelycum is structurally developed.

- **Effects of pH on ammonia toxicity and their influences on survival and growth of the early larval stages of giant tiger shrimp**

(Thesis Research)

Acute 96-h tests showed that ammonia toxicity increased with increasing pH. Estimated median lethal time (LT<sub>50</sub>) decreased from 101.09 to 25.16 h for protozoa at 8 ppm, 115.79 to 11.26 h for mysis at 24 ppm, and 51.41 to 22.58 h for post-larvae at 52 ppm ammonia when pH increased. A 16-day ammonia-pH combination chronic test showed that survival was significantly affected by ammonia and pH. Survival was higher in the control than at 3 and 6 ppm ammonia; survival was also higher in pH 7.5 than at pH 7.0 or 8.5. Growth rate was affected by ammonia but not pH.

- **Optimal growth conditions of common phytoplankton species used in shrimp/finfish hatcheries in large outdoor continuous culture**

At a flow rate of 30 ml/min, chemostat cultures of the diatom, *Chaetoceros calcitrans*, attained a log phase growth similar to a batch culture. Although higher biomass yields and chlorophyll *a* content were noted, diatom growth may only be extended to 12 days due to clumping of cells. At flow rates of 60

and 90 ml/min, the culture can be extended to 18 days but biomass yields and chlorophyll *a* were lower. Poor growth and survival of *Artemia* were obtained in the receiving tank probably due to insufficient cell density in the chemostat tank.

- **Evaluation of CPSP and PROTIBEL as potential protein sources for shrimp feeds**

Protein sources consisting of hydrolyzed fish protein (CPSP 90 and CPSP G) and plasmolyzed lactic yeast (PROTIBEL) were incorporated as a protein replacement in a basal diet for giant tiger shrimp postlarvae. The experimental diets are as follows: basal diet (diet 1), 5% CPSP 90 (diet 2), 5% CPSP G (diet 3), 2% PROTIBEL (diet 4), 7% PROTIBEL (diet 5), and commercial (diet 6). After 6 wk, percent weight gain among control (diets 1 and 6) and diet 5-fed shrimps were similar and significantly higher compared with shrimps fed diets 2, 3, and 4. Highest survival was obtained among shrimps fed diets 2 and 3, but these were not significantly different from those fed diets 4 and 5. Shrimps fed the control diets had significantly lower survival rates.

- **Amino acid requirement of giant tiger shrimp: Lysine, threonine, and valine**

The threonine requirement of giant tiger shrimp postlarvae was determined using amino acid test diets with casein-gelatin as a protein source and containing graded levels of threonine at 1.5, 2.3, 3.1, 3.9, 4.7, and 5.5% of dietary protein. Mean crude protein content of the diets was 35%. After 6 wk, mean weight gain ranged 352-584% while survival rate varied 70-85%.

- **Effect of butylated hydroxytoluene on the quality of giant tiger shrimp diets stored at different temperatures**

Practical diets with or without an antioxidant, butylated hydroxytoluene (BHT), were stored at 10, 20, 30, or 40°C for 10 wk. These diets were fed to shrimp postlarvae (mean body weight, 0.85 g) for 2 months. Thiobarbituric acid levels, an index of oxidative rancidity, were higher in shrimp diets with no BHT stored at 10, 20, 30, and 40°C than diets with BHT. No significant differences in growth and survival were observed in shrimps fed diets with or

without BHT stored at these four temperature conditions. Weight gain ranged from 205 to 507% and 226 to 470% for shrimps fed diets with and without BHT, respectively. Survival rate of shrimps fed diets with or without BHT ranged 60-100%.

- **Quality assessment of prawn feeds and feed ingredients: Thiobarbituric acid value, urease activity, aflatoxin level, and the biological effects on tiger prawn**

Commercially available shrimp feeds measured for aflatoxin (AFL) content by high pressure thin layer chromatography had levels of not detectable (11.1%), 10-40 ppb (86.3%), and 60-120 ppb (3.6%). Market-sized shrimp fed SEAFDEC-formulated diets containing 0 and 50 ppb AFL had significantly higher survival (76 and 72%, respectively) compared with those fed diets with 100 and 200 ppb AFL (55 and 51 %, respectively). Shrimp fed a diet with 200 ppb AFL for 8 wk showed negative growth. However, AFL levels in animal tissues were not detected. Histopathological observations revealed various degrees of atrophy and inflammation in the hepatopancreas of shrimp fed diets containing various levels of AFL.

- **The effect of chemoattractant on the growth and feed conversion of giant tiger shrimp juveniles**

Basal diets with 27% animal and 33% plant protein in the diet were enhanced with a chemoattractant at 0, 0.5, 1.0, 1.5, and 2.0% and fed to giant tiger shrimp juveniles in tanks. Shrimp growth was not significantly different among treatments. Increasing the plant protein level (soybean meal, 38%) but decreasing animal protein content to 22% in the basal diet with 1.5% chemoattractant resulted in highest growth and survival rates. However, feed intake was not significantly different among shrimps fed any of the test diets.

- **Evaluation of some local binding materials for shrimp diet**

Water stability after 8 h of shrimp diets bound by 3% *Eucheuma*, *Gracilaria*, cowpea, corn starch, or agar were similar (75.6-76.3%) to the control diet (wheat gluten) (76.7%). High percent weight gain of 1222% and 1018% were obtained in shrimp fed diets

bound by agar and corn starch, respectively, compared with shrimp fed diets bound by *Eucheuma*, *Gracilaria*, cowpea, and wheat gluten. However, higher survival (52%) was attained in shrimp fed diets bound by *Eucheuma* and cowpea than the other treatments. Apparent dry matter digestibility detected by chromic oxide was significantly higher in shrimp fed diets bound by cowpea, agar, *Eucheuma*, and *Gracilaria* than those fed diets bound by corn starch and wheat gluten.

- **Effect of certain chemotherapeutants on survival and growth of brine shrimp (*Artemia* sp.) nauplii**

Several 24 h bioassay tests were conducted to determine the tolerance level of *Artemia* nauplii to a fungicide (Treflan-R) and several antibiotics (oxytetracycline, furazolidone, erythromycin, and sodium nifurstyrenate). Instar II and III nauplii were tolerant to these chemotherapeutants; however, these substances delayed molting.

- **Investigations on the vertical and horizontal transfer mechanisms of the luminescent bacteria, *Vibrio harveyi*, in giant tiger shrimp hatcheries**

*Vibrio harveyi* was tolerant to a wide range of temperature (9-37°C) and exhibited fastest growth between 24 and 36.5°C. Bacterial isolation showed that the diatom, *Skeletonema costatum*, like *Chaetoceros calcitrans*, does not harbor *V. harveyi* at any phase of its growth. Screening of dominant bacteria from nearshore seawater, sediments, and intestinal contents of postlarval shrimp was done to select strains that compete with *V. harveyi* populations. Of the 80 bacterial strains tested, only bacteria from shrimp intestine and sediments inhibited growth of *V. harveyi*. However, competition experiments in artificial medium and seawater showed no inhibition of *V. harveyi* when grown with the isolated bacterial strains in mixed cultures.

#### **In progress:**

- Verification studies of SEAFDEC-developed shrimp hatchery techniques: Comparison of water management techniques used in low density larval rearing of giant tiger shrimp

- Growth, survival, and production of giant tiger shrimp reared initially in *hapa* nets and released in grow-out pond
- Economic assessment of the giant tiger shrimp hatchery industry in Panay Island
- Growth performance of giant tiger shrimp fed formulated diet without vitamin and mineral supplement
- Selective breeding of penaeid shrimps. I. Relation of reproductive performance and morphometric traits with body size/tail weight in *Penaeus indicus*
- *In-vitro* digestibility study of locally available feed-stuffs for white shrimps and sea bass

## **S** TUDIES ON MOLLUSCS (*PLACUNA PLACENTA*, *P. SELLA*, *CRASSOSTREA IREDALEI*, AND *PERNA VIRIDIS*)

Four studies were conducted on molluscs: one on the slipper oyster (*C. iredalei*) and green mussel (*P. viridis*), two on the window-pane oyster or "kapis" (*P. placenta*), and one on the saddle-shaped oyster or "bay-ad" (*P. sella*). The study on *P. sella* has been completed while data on the other three studies are still being analyzed.

The socioeconomic study of oyster and mussel farming in western Visayas was funded by the IDRC of Canada thru ICLARM and the Asian Fisheries Social Science Research Network. The study was conducted by a multidisciplinary team of an aquaculturist, sociologist, and economist. The objectives of the study were to: (1) determine the characteristics and social conditions of oyster and mussel farm operators, (2) assess the farming methods and technology

practiced in oyster and mussel culture, (3) analyze the detailed input-output data of operations and their production performance indicators of efficiency in terms of resource utilization and rate of returns, and (4) determine the development potential, identify problems and constraints, and formulate appropriate management policies that would sustain the development and viability of the oyster and mussel industry.

The studies on the window-pane oyster were aimed at (1) seed production in the laboratory and (2) evaluation and repopulation of depleted beds.

The study on *P. sella* was aimed at determining (1) the natural spawning season of the population at Banate, Iloilo and (2) the ideal period for commercial harvest in the area.

Reported by WG Gallardo - commodity team leader; RT Buensuceso, JM Ladja - team members.



"Kapis shell",  
*Placuna placenta*

- **Spawning induction of *Placuna placenta* with chemical stimuli in the laboratory**

At 34 ppt and 24.5°C, 11 of 18 (61.1%) window pane oyster released eggs (20.4-142.8 µm dia.) 30 min after injection of 1 ml of 2 mM serotonin. However, only one of the 7 serotonin-injected males spawned. Filtered seawater-injected controls (6 females, 6 males) did not spawn.

Slipper oyster (*Crassostrea iredalei*) and green mussel (*Perna viridis*)

- Socioeconomic study of oyster (*Crassostrea iredalei*) and mussel (*Perna viridis*) farming in western Visayas

About 2000 small-scale fishermen residing in coastal areas or along river-beds culture the slipper oyster and/or green mussel as an alternative source of livelihood. Mussels are farmed in Aklan, Capiz, and Negros Occidental by the stake and raft methods. Oysters are cultured using the bottom, stake, rack hanging, and raft hanging methods in Iloilo, Aklan, Capiz, and Negros Occidental. Lack of buyers, bad weather conditions, net losses, lack of capital, poaching, and conflict with fishpond and boat owners were major problems identified by the oyster and mussel farmers.

"Bay-ad",  
*Placuna sella*

- Reproductive cycle and condition monitoring of *Placuna sella*

The reproductive cycle of the saddle-shaped oyster, *Placuna sella*, in Banate, Iloilo was investigated from Feb 1990 to June 1991. Developing gonads were present in all months except Sept. Ripe gonads were found in Mar, Apr, and May but spawning occurred Jan- Oct. Gonads were either spent or developing in Nov and Dec. The present data suggest that *P. sella* has a prolonged spawning season.

**In progress:**

- Evaluation and restocking of depleted *Placuna placenta* beds

**S** TUDIES ON SEAWEEDS (*GRACILARIA* SPP.)

Seaweed studies had one main objective: strain selection of *Gracilaria* and *Gracilariopsis* as source of agar. Main research areas included stock assessment - biology, ecology, culture techniques - and agar characterization. Six studies were conducted.

Reported by AQ Hurtado-Ponce - commodity team leader; Ma TR de Castro, MR Luhan - team members.

**Seaweeds**

- **Influence of some environmental factors on the growth rate and agar quality of selected *Gracilaria* species in Iloilo** (Thesis Research)

A survey from Apr to Nov showed that *Gracilaria heteroclada* was abundant in Zarraga and Estancia. *G. blodgettii* and *G. verrucosa* were present only until June in Guimbal and Concepcion, respectively. Agar yield from *G. heteroclada* (25.02%) extracts was highest among the *Gra-*



*cilaria* species; *G. blodgettii* (7.22%) was lowest. Gel strength was highest from *G. heteroclada* (725 g cm<sup>-2</sup>) but was lowest in *G. verrucosa* (9 g cm<sup>-2</sup>) extracts. From these results, *G. heteroclada* had the best biomass production and agar quality. Outdoor and indoor tank cultures of this species - to determine the influence of some environmental factors on agar quality - are in progress.

- **Seaweeds cultivation at Malalison Island, Culasi, Antique**

Cuttings of *Kappaphycus alvarezii* var. *tambalang* and *Euचेuma denticulatum* were cultured along the shallow reefs of Malalison Island using vertical, cluster, and horizontal hanging long line method. Grazing by herbivorous fish appeared to be rampant especially near the bottom of the line culture.

- **Assessment of the natural bed of *Gracilaria* sp. at Balabago, Jaro, Iloilo** (Thesis Research)

The effect of different environmental factors on the seasonality of biomass production, reproductive state, and agar quality of *Gracilaria heteroclada* was investigated. Peak biomass was observed in Feb (45 g/m<sup>2</sup>) and lowest biomass in July (1.15 g/m<sup>2</sup>). Carposporophytes and tetrasporophytes were most abundant in Jan (48%) and May (64%), respectively, but were low during the rest of the year. Agar yield was negatively correlated with gel strength. Good and poor quality agar were observed during the dry and wet seasons, respectively.

- **Biology and phenology of *Gracilaria*: Managing a *Gracilaria* bed**

*G. heteroclada* showed varying monthly growth rates and yield when harvested at different levels (25, 50, 75, 100%). Plants regenerate in 3 months when the stock was completely harvested. Regardless of the month, higher growth rates and yield were recorded

when 75% of the plants were harvested. However, growth rate was negative when 25% of the plants were harvested. The amount of seedstock for the succeeding culture period appear to influence growth rate and yield.

- **Biology and phenology of *Gracilaria*: Seasonal variation on the quality and quantity of agar gel from *Gracilaria***

Monthly variations in gel strength were highly significant among agar extracted from *Gracilariopsis heteroclada* cultured at different water depths (25, 50, and 100 cm). Monthly agar yield and percent clean anhydrous weed were highly significant, although no significant differences in these parameters were observed among extracts of *G. heteroclada* cultured at different depths.

- **Polyculture of *Gracilaria* and *Lates calcarifer* in floating net cages**

Ten-gram fragments of *Gracilariopsis heteroclada* were inserted in a polypropylene rope, suspended at different water depths (25, 50, and 100 cm), and cultured from Apr to Oct with *Lates calcarifer* fingerlings (22-25 cm and 158-252 g) in floating net cages (1x1x1.5 m). Specific growth rate (SGR) of *G. heteroclada* was significantly influenced by the interaction of water depth, culture month, and stocking density of sea bass.

Growth rate of *G. heteroclada* was highest when the plant was suspended and cultured at a depth of 25 cm in Apr; seaweed was unaffected by the presence or absence of sea bass. Growth rate was lowest among plants cultured without sea bass at 100-cm depth in Sept and Oct. Production ranged 10.3-172.4 g (dry)/m<sup>2</sup>/month or about 2 tons (dry)/ha/month.

After 210 days of culture, sea bass attained 35-39 cm and 565-741 g. Weight gain and total production of fish in each cage was 195-258% and 6780-9637 g, respectively. Survival rate was 92-100%.



## **S**TUDIES ON FISH MICROBIOLOGY

The Epizootic Ulcerative Syndrome (EUS) is a major disease among freshwater fishes. The disease was initially reported in 1977 in Singapore but major outbreaks started in 1980 in Indonesia and Malaysia; 1982 in Thailand and Laos; 1984 in Burma; and 1985 in the Philippines. From then on, it became an annual outbreak usually occurring in the cold months of the year. Subsequently, the disease spread to Cambodia, Bangladesh, India, Sri Lanka, Vietnam, and lately, Nepal.

EUS hit the headlines in Philippine newspapers because a large number of freshwater fishes, especially snakeheads and catfish, were affected. When the disease occurred in the Philippines, the first outbreak was recorded in Laguna de Bay; outbreaks in Tarlac, Pampanga, Mindoro, and other provinces followed. Outside Luzon, only Naujan (Mindoro) has EUS.

The EUS project was started in 1989 with the following objectives: (1) identification of etiologic agents, (2) determination of environmental factors that trigger or enhance disease development, and (3) histopathology.

Studies in 1991 were on environmental factors, associated parasites, and histopathology; bacterial and viral studies were also conducted.

Reported by GD Lio-Po - project leader; EC Lacierda, FP Palisoc Jr, CL Pitogo - team members.



- **Parasitology and epidemiology of epizootic ulcerative syndrome (EUS)-positive snakehead, *Ophicephalus striatus*, with notes on the predisposing environmental parameters in Laguna Lake and Lake Naujan**

A high prevalence (43%) of EUS-infected snakehead was observed in mid-Nov and Dec in Laguna Lake, although none was recorded in Naujan Lake, Mindoro during the same period. These two lakes differed significantly in depth, turbidity, chloride, and water hardness levels. Levels of most trace metals in sediments from both lakes were similar except copper and lead which were higher in Laguna Lake. Organochlorines such as heptachlor, endosulfan, and heptachlor epoxide were detected from the sediments of both lakes.

- **Histopathology of epizootic ulcerative syndrome (EUS) in snakehead, *Ophicephalus striatus*, of Laguna de Bay (Thesis Research)**

Histopathological examination of lesions from moderately and severely EUS-affected snakehead showed severe, extensive necrotizing granulomatous myositis. The focal or multifocal inflammatory response extended into the heart, liver, spleen, and kidney. Hematocrit, hemoglobin, and serum protein levels of normal and seemingly normal fish were significantly higher than fish with severe EUS lesions. Healthy fish stocked in Binangonan with or without EUS-positive fish developed typical EUS lesions after 10-14 days and 18-20 days, respectively.

- **Viral and bacterial etiology of the epizootic ulcerative syndrome (EUS) (Thesis Research)**

Viral studies: Primary cell lines from snakehead heart, kidney, liver, ovary, and spleen and catfish heart, liver, ovary, and spleen were successfully established and propagated to the 17th until the 36th

EUS-infected fishes from Laguna Lake, Bautista (Pangasinan), Candaba (Pampanga), and Naujan Lake (Mindoro) were assayed for virus in snakehead cells. Cytopathic effects were induced by selected fish filtrates on monolayered test cells and subsequently confirmed to the 5th and 6th blind passages.

Bacterial studies: The possible modes of entry [e.g., intramuscular (IM) injection, gastric lavage, fish food, immersion of fish injured by skin/muscle cut, scale removal, dermal scraping or incision, fish bite, and co-habitation with golden snails at 21-25-C] of the bacteria, *Aeromonas hydrophila*, into snakehead and Thai catfish were investigated. Dermomuscular pathology of test fish was induced only by IM injection of the bacteria. Moreover, three EUS-associated bacterial isolates from Thailand (*Aquaspirillum*, *Streptococcus*, *Pseudomonas*) injected intraperitoneally (IP) into snakehead and catfish did not induce lesions or cause mortalities among test fishes. However, IM injection of *Streptococcus*, *Pseudomonas*, *Aquaspirillum* induced moderate, slight and very slight dermomuscular lesions, respectively, on test fishes. None of these bacterial isolates induced lesions as severe as those produced by *A. hydrophila*.

by an earthquake. Construction of SEAFDEC's Seafarming Station House started in May.

Strengthening of the Fishermen's Association of Malalison Island (FAMI) started with a basic leadership orientation seminar held in September. FAMI was registered with the Securities and Exchange Commission on June 24, 1991. By November, a full-time community organizer from PROCESS (Participatory Research Organization of Communities and Education Towards Struggle for Self-Reliance) Foundation, Inc., a non-government organization with demonstrated capability in organizing people's organizations and implementing livelihood activities, was assigned in the island.

Research activities for the year concentrated on the following:

1. Survey of seagrasses, seaweeds, fish, corals, and other invertebrates; and assessment of physico-chemical properties of surrounding waters;
2. Documentation of existing sea tenure practices and territorial use rights in fisheries;
3. Identification, assessment, and evaluation of present and potential utilization of resources; and
4. Cultivation of seaweeds using the hanging (long-line) technique.

Reported by FJ Lacanilao- project leader;  
RF Agbayani, RM Cheong, GPB Samonte, SSIar, E Amar  
- team members.

## **S** TUDIES IN THE PILOT SEAFARMING AND SEARANCHING PROJECT

Actual work in Malalison Island started in January with resource assessment, inventory of social services, and a household census. In February, "Kapihan" or all-purpose hut was constructed to provide the villagers with a place to hold meetings and other activities. In March, three new deep wells were constructed to augment inadequate water supply. In both instances, SEAFDEC provided materials while the villagers contributed labor services in the "bayanihan" spirit. The villagers likewise repaired their reservoir, the only source of drinking water which was destroyed

### • **Resource assessment of selected marine communities in Malalison Island**

Initial frequency and cover of 5 species of seagrasses were determined. Macrobenthic algae consisting of 64 species were identified with their potential economic uses. Visual census of fish populations estimated abundance of 210 species. Hydrographic data have been recorded to determine potential sites for artificial reefs.

### • **Economic utilization of resources in Malalison Island**

The village transect of Malalison Island which shows the resources from the coastal to the land areas is 80% complete. Data were gathered through group interviews of couple (husband and wife) fisherfolk and through actual inspection of the whole island. Group interview encouraged discussion among re-

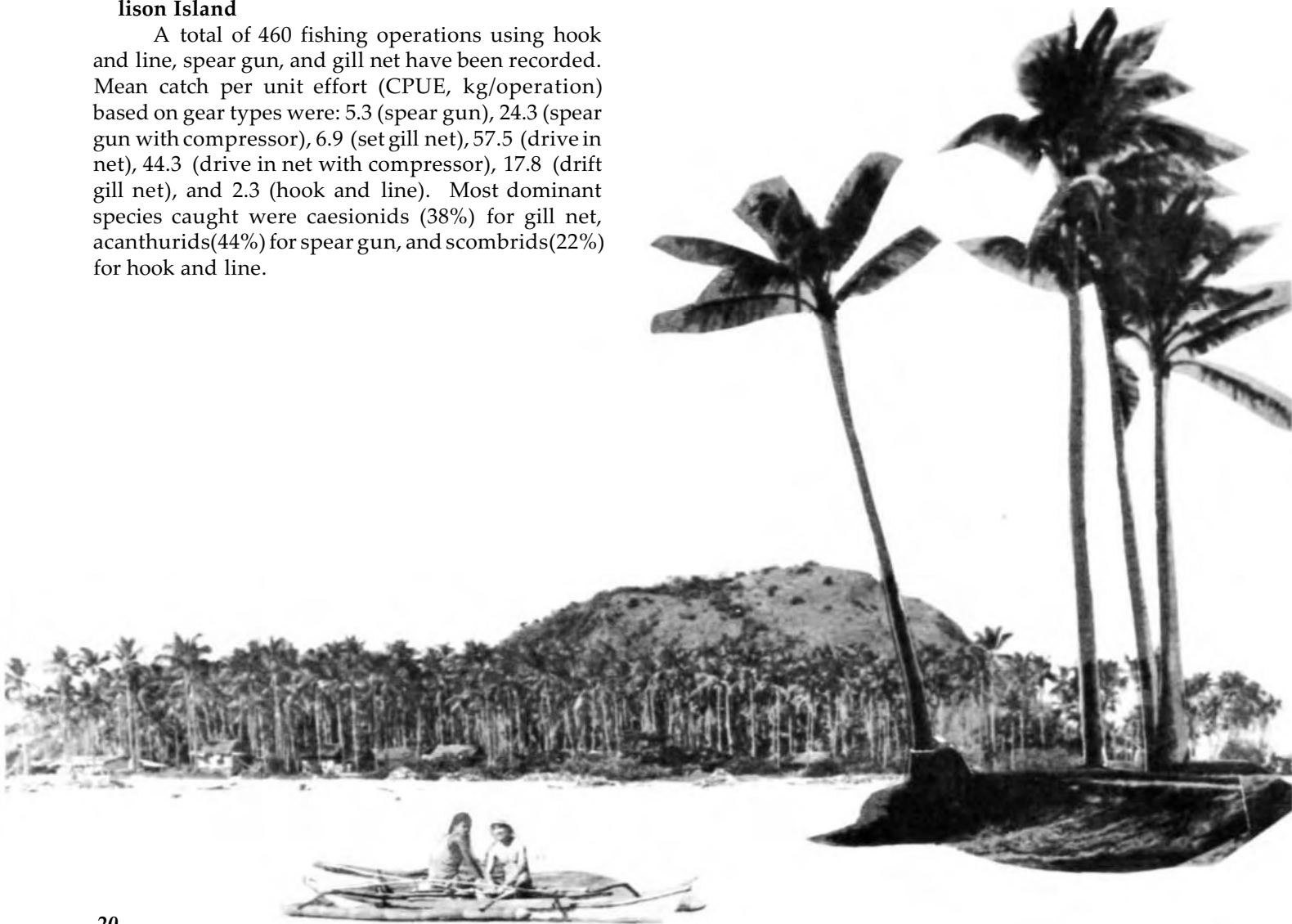
spondents. It was observed that the wives were more conversant of the resources of the island.

- **An investigation of traditional marine boundaries and territorial use rights in fisheries in Malalison Island**

Traditional users of fishing grounds around Malalison Island include fishers from neighboring barangays. There is no ownership of specific fishing spots by an individual or a group of fishers as documented in some Pacific Islands.

- **Stock assessment of fish populations in Malalison Island**

A total of 460 fishing operations using hook and line, spear gun, and gill net have been recorded. Mean catch per unit effort (CPUE, kg/operation) based on gear types were: 5.3 (spear gun), 24.3 (spear gun with compressor), 6.9 (set gill net), 57.5 (drive in net), 44.3 (drive in net with compressor), 17.8 (drift gill net), and 2.3 (hook and line). Most dominant species caught were caesionids (38%) for gill net, acanthurids(44%) for spear gun, and scombrids(22%) for hook and line.



## Research seminars

Completed and preliminary results of research studies are presented in weekly in-house seminars attended by AQD staff. Visiting scientists and other guests are also invited to talk about their research and experiences.

<u>DATE/SPEAKER</u>	<u>TITLE</u>
7 Feb A HARA*	Studies on female-specific serum protein (vitellogenin) in fish
14 Feb CL PITOGO	Studies on the sources of luminescent <i>Vibrio harveyi</i> in <i>P. monodon</i> hatcheries
21 Mar FG AYSON	Changes in thyroid hormone levels in plasma, eggs, and yolk-sac larvae of rabbit-fish ( <i>Siganus guttatus</i> ) after maternal thyroxine injection
26 Mar S KUMAGAI*	Studies on <i>Brachionus</i> culture
18 Apr MR ROMANA	Comparing the response of three <i>Oreochromis niloticus</i> strains to feed restrictions
02 May PF SUBOSA	Yield of <i>Penaeus monodon</i> Fabricius in brackishwater ponds applied with different fertilizer combinations
09 May FP PALISOC JR	Relationships between epizootic ulcerative syndrome in fish and the environment in Laguna Lake
06 June JD TOLEDO	Cryopreservation of different strains of the euryhaline rotifer <i>Brachionus plicatilis</i> embryos
11 June MFA GOOSEN*	Applications of micro-encapsulation technology in medicine and biotechnology
20 June C DA COSTA-REIS	<i>In vitro</i> protein digestibility and growth of milkfish fingerlings fed various protein sources in three different salinities

04 July RT BUENSUCESO	Growth and survival of transplanted oysters <i>Placuna placenta</i> in Igang, Guimaras
18 July IG BORLONGAN	Dietary requirement of milkfish juveniles for essential amino acids
01 Aug J TORRES*	Taxonomic studies on motile <i>Aeromonas</i> spp. associated with healthy and epizootic ulcerative syndrome-positive fish
05 Sept R ORDONIO**	The effect of thyroxine (T <sub>4</sub> ) on the development and metamorphosis of sea bass larvae
12 Sept RF AGBAYANI	Economics of sea bass broodstock farm in floating cages
25 Sept AE SERRANO JR*	Arylformamidase in fish
26 Sept NOOR HAMID**	Effect of pH on ammonia toxicity and its influence on survival and growth of the early stages of <i>P. monodon</i>
26 Sept AE SANTIAGO	Tilapia cage culture and the limnological changes in Sampaloc Lake
03 Oct S MORIOKA**	Study on milkfish larvae in the intertidal zone
07 Oct H FERGUSON*	Gill diseases in fish
10 Oct S SIAR	Acceptability of territorial use rights in fisheries: Towards community-based management of small-scale fisheries
17 Oct LMAB GARCIA	Lunar spawning rhythm in sea bass

23 Oct JDT FERMIN	Induced breeding by LHRHa and pimozide in the freshwater Asian catfish, <i>Clarias macrocephalus</i>
24 Oct AC EMATA	Egg and larval production of milkfish reared in concrete tanks
30 Oct GPB SAMONTE	Pond culture of mud crab, <i>Scylla serrata</i> : An economic analysis
21 Nov WG GALLARDO	Reproductive cycle of the saddle-shaped oyster, <i>Placuna sella</i> (Gmelin 1791), in Banate, Iloilo
27 Nov MLA ARALAR	Effects of heavy metal mixtures on two Nile tilapia strains
28 Nov AC GONZAL	Broodstock and breeding management of bighead carp, <i>Aristichthys nobilis</i> , in hatcheries around Laguna de Bay
05 Dec MR DE LA PEÑA	Cell growth of <i>Chaetoceros calcitrans</i> in continuous culture
ET QUINTIO	Morphological changes in the ovary in relation to the development of the external genitalia and molt cycle in captive <i>Penaeus monodon</i>
10 Dec RM CHEONG	A preliminary survey of snapper (genus <i>Lutjanus</i> ) in Panay as potential species for culture
T HIRANO*	Mode of action of growth hormone in teleosts
EG DE JESUS**	Hormonal regulation of metamorphosis in Japanese flounder

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\*Visiting Scientist. \*\*Guest.

# RESEARCH PUBLICATIONS: Source of primary information

Journals are sources of primary information - information derived from basic or applied research that has not been published anywhere. These are essentially useful to scientists (and future scientists) working on the same field.

For this year, 72% of the Department's published papers are contained in refereed journals, an increase from the combined 48% for 1976-90. Seen against the number of senior research staff (excluding expatriates), this means a ratio of 0.75 journal publication to one researcher (or three publications for every four researchers). From these papers, and from others published by other research institutions, training and extension modules can be prepared for dissemination to fishfarmers/extension workers.

## JOURNAL PUBLICATIONS AND EDITED PROCEEDINGS

- Ayson FG. 1991. Induced spawning of rabbitfish, *Siganus guttatus* (Bloch), using human chorionic gonadotropin (HCG). *Aquaculture* 95:133-137.

A positive spawning response of rabbitfish females to two injections of HCG at 2.0 IU/g BW given 24 h apart was observed. The latency period after hormone injection was inversely related to the initial oocyte size. Minimum initial oocyte size required for spawning without hormone injection was 0.46 mm. HCG induction of spawning was necessary for females with initial oocyte size of <0.45 mm. Number of eggs spawned (424 000), fertilization rate (96%), and hatching rate (59%) did not differ from those of naturally spawned fish.

- Baldia SF, Nishijima T, Hata Y, Fukami K. 1991. Growth characteristics of a blue-green alga *Spirulina platensis* for nitrogen utilization. *Nippon Suisan Gakkaishi* 57:645-654.

The effects of physico-chemical factors and nutrients on the growth responses of *Spirulina platensis* isolated from Lake Kojima (K-2 strain) were determined. The optimum conditions for growth were the following: light intensity of 2,500-10,000 lx, pH 6.5-9.0, 30-35°C temperature and 0-7.6‰ of chlorinity. *S. platensis* (K-2 strain) requires no vitamins for growth essentially. However, growth enhancement was observed with vitamin B<sub>12</sub> among the B-group vitamins tested. Likewise, hormones such as kinetin and giberellin exhibited stimulatory effect on growth. The alga could utilize inorganic and organic phosphorus sources. Values on the different growth parameters for orthophosphate, β-glycerophosphate, adenosine diphosphate, and phosphocreatine were comparatively similar; half-saturation constant, maximum growth rate, minimum cell quota and level for saturated growth yield were about 0.01-0.02 mgP/l, 0.8/day, 0.1-0.2 pg P/cell, and 0.4-0.7 mg P/l, respectively.

- Baldia SF, Nishijima T, Hata Y. 1991. Effects of physico-chemical factors and nutrients on the growth of *Spirulina platensis* isolated from Lake

**Kojima, Japan. Nippon Suisan Gakkaishi 57:481-490.**

The growth characteristics of *Spirulina platensis* (K-2 strain), a freshwater isolate from Lake Kojima, was determined for nitrogen utilization. The alga can utilize nitrate, nitrite, ammonia, urea, casamino acids, and some amino acids as nitrogen sources with best growth at urea and asparagine. The stimulating effect of some organic extracts and nucleic acids was observed. Values on the different growth parameters for nitrate, ammonia, urea, and asparagine were the following: half-saturation constant ( $K_s$ ) of 1.2, 0.25, 0.15 and 0.10 mgN/l, respectively; maximum growth rate ( $\mu_{max}$ ) of 0.48, 0.67, 1.2 and 0.7/d, respectively; and nitrogen level for saturated growth yield of 11, 5, 10 and 8 mg N/l, respectively. Results indicated that the metabolic efficiency of the alga is best on urea and is worst on nitrate. The alga was found to have specific growth parameters for each nitrogen source independent of its preconditioning in different nitrogen sources. Enzyme systems for ammonia and urea assimilation seemed to be constitutive but those for asparagine assimilation maybe induced by depletion of nitrogen or incubation in the sole nitrogen sources of asparagine.

- **Baticados MCL, Pitogo CL. 1990. Chlorination of seawater used for shrimp culture. Israeli J. Aquacult. - Bamidgeh 42:128-130.**

Chlorination of sand-filtered and microfiltered seawater for 24 hours significantly reduced the initial bacterial load from  $10^5$  to  $10^0$ - $10^1$  colony forming units (cfu) per ml. The total plate counts steadily increased however, after neutralization, reaching levels similar to those of untreated water 24 hours later. Results suggest that chlorine exerts bacteriostatic effects at 5 to 30 ppm and that water should be used within 6 hours after neutralization when the bacterial load is at its minimum level of no higher than  $10^2$  cfu/ml.

- **Baticados MCL, Tendencia EA. 1991. Effects of Gusathion A on the survival and shell quality of juvenile *Penaeus monodon*. Aquaculture 93:9-19.**

Juvenile *Penaeus monodon* (body weight= 10-20 g) were exposed to a commonly used organic phosphate pesticide, Gusathion A, in ponds for 96 h. Prawns exposed to 1.5-150 ppb Gusathion had 27-53% shell softening, with a 96 h LC50 of 120 ppb.

Histopathological changes in the gills and hepatopancreas included slight hyperplasia of the gill epithelium, delamination of the hepatopancreatocytes, and general necrosis and degeneration of these tissues.

- **Baticados MCL, Pitogo CL, Paner MG, de la Pena LD, Tendencia EA. 1991. Occurrence and pathology of *Penaeus monodon* baculovirus infection in hatcheries and ponds in the Philippines. Israeli J. Aquacult. - Bamidgeh 43:35-41.**

Samples from *Penaeus monodon* hatcheries (2-3 day old larvae or Zoea 1 to 34 day old postlarvae or PL<sub>34</sub>) and ponds (15 to 159 days old in the pond) were histologically examined for the presence of eosinophilic occlusion bodies in hypertrophied nuclei of the hepatopancreas which is indicative of *P. monodon* baculovirus infection. The earliest stage found infected in the hatcheries was PL<sub>3</sub>. Infected shrimp from ponds had slow growth rates and generally pale yellow to reddish brown hepatopancreas. The infection was also characterized by the necrosis and degeneration of the hepatopancreatic tubules with secondary bacterial invasion.

- **Bautista MN, del Valle MJ, Orejana FM. 1991. Lipid and fatty acid composition of brackishwater- and freshwater-reared milkfish (*Chanos chanos* Forsskal). Aquaculture 96:241-248.**

Lipid and fatty acid composition of the various sections of brackishwater- and freshwater-reared milkfish were determined by chromatographic methods. Lipids consisted mainly of the neutral type, which in turn was composed primarily of triglycerides and cholesterol esters. Palmitic and stearic acids were the predominant saturated fatty acids in both types of fish, although the brackishwater-reared milkfish contained more palmitic acid and the freshwater-reared milkfish more stearic acid. Unsaturated fatty acids of C<sub>16</sub> and C<sub>18</sub> were more characteristic of the freshwater-reared milkfish lipid, while those of C<sub>20</sub> and C<sub>22</sub> were the major acids of the brackishwater-reared milkfish lipid. Saturation and unsaturation in the fatty acid composition characterized both types of fish although the brackishwater-reared milkfish lipids had fatty acids of higher saturations (C<sub>20</sub> and C<sub>22</sub>).



## Research publications

Number of research publications in scientific journals and proceedings from Jan to Dec, by species

Commodity	Breeding	Nursery	Farming systems	Feed dev'l	Fish health	Others	Total
Sea bass	(2)	2(1)		(1)			2(4)
Grouper	-	2	-	-	-	-	2
Rabbitfish	2	-	-	1	-	-	3
Milkfish	-	2	4(2)	1(3)	(1)	•	7(6)
Tilapia	-	-	2	-	-	-	2
Carp	1(1)	-	-	2	-	-	3(1)
Catfish	1(1)	(1)	-	-	-	-	1(2)
Tiger shrimp	1	-	3(2)	3(1)	2(1)	2	11(4)
Molluscs	(1)	-	-	-	-	-	(1)
Seaweeds	•	-	2	-	(1)	-	2(1)
Others	3(2)	-	1	1	1	10(6)	16(8)
Total	8(7)	6(2)	12(4)	8(5)	3(3)	12(6)	49(27)

In parentheses are papers in press.

- **Borlongan IG. 1991. Arginine and threonine requirements of milkfish (*Chanos chanos* Forsskal) juveniles. *Aquaculture* 93:313-322.**

Growth studies were conducted on milkfish (*Chanos chanos* Forsskal) juveniles to determine the quantitative requirements for arginine and threonine. The amino-acid test diets (40% crude protein) contained casein and gelatin supplemented with crystalline L-amino acids to provide an amino-acid profile similar to milkfish protein except for the test amino acid. Each set of experimental diets consisted of six isonitrogenous and isocaloric diets containing graded levels of the essential amino acid to be tested. Break-points in the growth curves which represent the optimum dietary concentration of arginine and threonine for fish growth were determined by the broken-line regression method. Based on dry diet, the requirement of milkfish juveniles for arginine is 2.10% and for threonine, 1.80%. These values correspond to 5.25% arginine and 4.50% threonine when expressed as a percentage of dietary protein.

- **Catacutan MR. 1991. Apparent digestibility of diets with various carbohydrate levels and the growth response of *Penaeus monodon*. *Aquaculture* 95:89-96.**

The digestibility of four isonitrogenous diets (40% crude protein) containing different levels (5%, 15%, 25% and 35%) of gelatinized breadflour as carbohydrate source were determined for *P. monodon* (average weight 30-40 g). The digestibility coefficient for protein ranged from 92.8 to 94.3%. Crude fat digestibility ranged from 90.0 to 92.8% and dry matter digestibility from 75.7 to 86.9%. Carcass crude protein was similar in all treatments but carcass crude fat decreased significantly ( $P < 0.05$ ) with increasing dietary carbohydrate.

The same diets were fed to a group of smaller *P. monodon* (average initial weight =  $0.139 \pm 0.011$  g) for 8 weeks. Weight gain, specific growth rate (SGR), feed conversion ratio (FCR) and survival rate did not differ significantly ( $P > 0.05$ ) among treatments. However, weight gain and SGR were lowest and FCR was poorest with 35% carbohydrate.

- **Catacutan MR. 1991. Growth and fatty acid composition of *Penaeus monodon* juveniles fed various lipids. *Israeli J. Aquacult. - Bamidgah* 43:47-56.**

A 4-week feeding trial was conducted to determine the growth and fatty acid composition of *Penaeus monodon* juveniles fed dietary lipids from different sources. The animal lipid (cod liver oil, pork lard and beef tallow) and plant lipid (soybean oil, coconut oil and corn oil) sources were fed at 4%, 8% or 12% levels in semi-purified diets. There was no significant interaction between lipid source and lipid level ( $\alpha = 0.05$ ) but the weight gain and specific growth rate of prawns fed 12% cod liver oil were significantly higher than all other treatments. Prawns fed soybean oil followed and then animals fed corn oil. Coconut oil, pork lard and beef tallow were poor lipid sources for the *P. monodon* juveniles. The fatty acid composition of the prawns reflected that of the dietary lipids and HUFAs were incorporated more into the polar lipid fraction. The fatty acids 16:0 and 16:1 increased in prawns fed no lipids. The ratio of n3/n6 was high in prawns fed cod liver oil. For juvenile *P. monodon*, 2.6% dietary HUFA enhance growth; levels of 18:2n6 greater than 5% have a negative effect.

- **Coloso RM, Hirschberger LL, Stipanuk MH. 1991. Uptake and metabolism of L-2-oxo-[<sup>35</sup>S] thiazolidine-4-carboxylate by rat cells is slower than that of L-[<sup>35</sup>S] cysteine or L-[<sup>35</sup>S] methionine. *J. Nutr.* 121:1341-1348.**

The uptake and metabolism of L-2-oxo-[<sup>35</sup>S] thiazolidine-4-carboxylate (OTC) was compared with that of L-[<sup>35</sup>S] cysteine and L-[<sup>35</sup>S] methionine in studies with freshly isolated rat hepatocytes, renal cortical tubules and enterocytes. All three <sup>35</sup>S-labeled substrates were metabolized to glutathione, inorganic sulfur and taurine by hepatocytes and to inorganic sulfur by renal tubules and enterocytes. The rate of metabolite production from OTC was always <30% of that from cysteine or methionine. The transport rate for uptake of [<sup>35</sup>S] OTC by hepatocytes was less than that observed for uptake of [<sup>35</sup>S] cysteine or [<sup>35</sup>S] methionine. The capacity of rat hepatocytes, renal cortical tubules and enterocytes to take up and metabolize OTC is substantially lower than that for uptake and metabolism of cysteine or its normal intracellular precursor, methionine.

- **Cuvin-Aralar MLA, Furness RW. 1991. Mercury and selenium interaction: A Review. *Ecotoxicol. Environ. Safety* 21:348-364.**

The paper reviews studies on mercury and selenium interaction. It includes effects of selenium on mercury toxicity on the organism, organ/tissue, and subcellular levels. The paper also touches on possible mechanisms of the "protective action" of selenium against mercury toxicity and deals briefly on the synergism between the two elements.

- **de Castro TR, Guanzon NG, Luhan MRJ. 1991. Assessment of stocks of a natural *Gracilaria* population on Panay Island, Philippines. Bot. Mar. 34:383-386.**

Two peaks in biomass were recorded from natural beds of *Gracilaria* sp. at Leganes, Iloilo and Batan, Aklan study sites. The major peak occurred in February 1989 for both areas. The minor peak occurred in September 1988 at Batan and October 1988 at Leganes. Highest biomass at Ivisan, Capiz occurred in May 1988. Lowest biomass was recorded in June at Batan and December 1988 at Leganes. At Ivisan, no biomass was recorded from November 1988 to February 1989. Correlation analysis showed no relationship between biomass and temperature or pH at all study sites. However, salinity was negatively correlated with biomass at Leganes and Batan. Rainfall was inversely correlated with biomass. Based on salinity data gathered from the three study sites, *Gracilaria* sp. is euryhaline and can tolerate a wide range of salinity. The results show a marked seasonality in the biomass of *Gracilaria* sp.

- **Emata AC, Meier AH, Hsiao SM. 1991. Daily variations in plasma hormone concentrations during the semilunar spawning cycle of the gulf killifish, *Fundulus grandis*. J. Exp. Zool. 259:343-354.**

Male and female gulf killifish, *Fundulus grandis*, were kept in large cages submerged in their natural habitat in the Gulf of Mexico. Gonadosomatic indices (GSI:  $100 \times \text{gonad weight/body weight}$ ) and blood samples were obtained from male and female fish every 4 hours (beginning at 1600) throughout a day on 3 separate days of the semilunar cycle: at the GSI and spawning peak (July 27-28), at midcycle (August 2-3), and on a day prior to the probable spawning peak (August 9-10). Blood samples of females were assayed for Cortisol, estradiol-17 $\beta$  (E<sub>2</sub>), progesterone, testosterone, thyroxine (T<sub>4</sub>), and triio-

dothyronine (T<sub>3</sub>). The daily rhythms of hormones at each of the three days during the cycle differed markedly from one another. At the spawning peak, E<sub>2</sub> and T<sub>3</sub> peaks occurred at 1200, testosterone and progesterone peaks were found at 2400 and the GSI and Cortisol peaks were at 0400. The GSI decreased sharply at 0800 indicating a period of probable spawning. At midcycle, most hormone levels were low throughout the day and the amplitudes of the hormone rhythms were suppressed. One day prior to the spawning peak, testosterone and progesterone variations (peaks at 2400) were similar to those found on the day of the first semilunar GSI and spawning peaks. Daily variations of other hormones, especially E<sub>2</sub>, were prominent on the day prior to peak spawning but different from those found on the day of peak GSI/spawning. In males, plasma concentrations of Cortisol, testosterone, T<sub>3</sub> and T<sub>4</sub> also underwent daily variations that differed from one another on the 3 days of the cycle. The results clearly demonstrate that there are dramatic changes in the daily variations of plasma hormone concentrations during the semilunar spawning cycle.

- **Fermin AC. 1991. Freshwater cladoceran *Moina macrocopa* (Strauss) as an alternative live food for rearing sea bass *Lates calcarifer* (Bloch) fry. J. Appl. Ichthyol. 7:8-14.**

Fifteen day old sea bass larvae were acclimated to 10‰ S and fed *ad libitum* levels of *Moina*, *Artemia* or *Moina* + *Artemia* (at 1:1 ratio). Fish kept at 32‰ S and fed *Artemia* served as a control. After 20 days, specific growth rates of fish ranged from  $8.8 \pm 2.5\%$ /day to  $12.9 \pm 1.4\%$ /day and did not differ significantly in any of the treatments ( $P > 0.05$ ). Survival rates of fish fed *Artemia* in either 10 ( $26.9 \pm 8.4\%$ ) or 32 ( $30.2 \pm 12.8\%$ ) ‰ S and *Moina* + *Artemia* ( $7.7 \pm 2.8\%$ ) were similar and higher than the *Moina*-fed group ( $2.6 \pm 1.4\%$ ). Results seemed to relate to poor utilization of *Moina* by younger sea bass (15-day-old).

In another experiment, the amount of *Moina* ingested in the presence or absence of *Artemia* by 15-, 20-, 25-, 30-, and 35-day-old sea bass was determined. Thirty-day-old sea bass fry ingested the highest number of *Moina*, whether with ( $17.19 \pm 1.96$ ) or without ( $25.29 \pm 2.93$ ) the addition of *Artemia*, than did the other age-groups ( $P < 0.05$ ). There was a low feeding incidence of *Moina* by 15-day-old sea bass. The number of ingested *Moina* was positively corre-

lated ( $r=0.6358$ ) to the fish body length. The amount of *Moina* ingested can be used as partial or complete substitutes for *Artemia*, provided they are sieved beforehand for efficient utilization by the younger sea bass larvae.

- **Fermin AC. 1991. LHRH-a and domperidone-induced oocyte maturation and ovulation in bighead carp, *Aristichthys nobilis* (Richardson). *Aquaculture* 93:87-94.**

Effects of intraperitoneal injections of LHRH-a and domperidone (DOM), given singly or in combination at two injections, on oocyte maturation, ovulation and spawning in bighead carp, *Aristichthys nobilis*, were investigated. Results were compared with the existing protocol using HCG+LHRH-a at 1800 IU and 20 $\mu$ g/kg BW, respectively, to induce spawning in bighead carp. Oocyte diameter of fish at 6 h after the second injection of LHRH-a + DOM and HCG + LHRH-a had significantly increased to 7.0% and 7.5% respectively, as compared to the 0 h group ( $P<0.05$ ); fish injected with LHRH-a, DOM or saline had significantly lower increases (1.0%, 2.0%, and 3.0%, respectively). Ovulation was induced in 75% and 60% of fish injected with LHRH-a + DOM and HCG + LHRH-a, respectively. In contrast, fish treated with LHRH-a, DOM or saline did not ovulate. Total eggs spawned, and fertilization and hatching rates did not differ significantly ( $P<0.05$ ) between the two groups with ovulated fish. Although injection protocols using LHRH-a + DOM and HCG + LHRH-a were equally effective in inducing spawning of bighead carp, the former had a lower combined cost than the latter.

- **Garcia LMaB. 1991. Spermiation response of mature rabbitfish, *Siganus guttatus* Bloch, to luteinizing hormone-releasing hormone analogue (LHRHa) injection. *Aquaculture* 97:291-299.**

A method to quantify the spermiation response of mature rabbitfish to hormonal therapy is described. Spermatocrit or packed sperm volume was measured after milt loaded in non-heparinized microhematocrit capillary tubes was centrifuged for 45 min at 15 000 x. Sperm density was estimated by a standard hemacytometer method. However, sperm density can be predicted from spermatocrit since their relationship is highly and positively correlated ( $Y = 29.5$

+ 2.95 X,  $r=0.83$ ;  $P<0.01$ ). Milt production by mature rabbitfish was highest (4.9 ml per kg body weight) at 24 h after injection of 20  $\mu$ g of luteinizing hormone-releasing hormone analogue (D-Ala<sup>6</sup>, Pro<sup>9</sup>-LHRH-ethylamide) per kg body weight and coincided with low spermatocrit (68%) and sperm density (14.1  $\times 10^6$  spermatozoa per ml milt) levels. These results demonstrate that spermiation in mature rabbitfish can be reliably assessed by a spermatocrit method and that LHRHa can effectively stimulate spermiation in this species.

- **Honculada Primavera J. 1991. Intensive prawn farming in the Philippines - Ecological, social, and economic implications. *Ambio*. 20:28-33.**

The benefits of intensive farming of the giant tiger prawn *Penaeus monodon* in the Philippines are discussed in relation to the environmental costs. Ecological effects include mangrove conversion into ponds; use of antibiotics and chemicals leading to drug resistance; dumping of pond effluents which affect neighboring ecosystems; and pumping of groundwater that causes saltwater intrusion and vulnerability to floods. In addition, these effects lead to social costs in the form of reduction in domestic and agricultural water supplies; decreases in the production of foodfish and other food crops; further marginalization of coastal fishermen; displacement of labor; and credit monopoly by big businessmen. Comparative economic analyses of three prawn-farming systems showed that, compared to extensive and intensive culture, semi-intensive farms give the best performance using undiscounted (payback period, return on investment) and discounted (net present value, internal rate of return) economic indicators. With a 20% fluctuation in inputs or selling price intensive farming will no longer be profitable because of the high variable cost. The paper concludes with recommendations for strict enforcement of existing government guidelines (e.g. ban on mangrove conversion); institution of new policies on the use of groundwater, seawater and public credit; diversification of cultured species; and emphasis on semi-intensive farming parallel with brakes on further intensification of prawn farming.

- **Marte CL, Duray MN. 1991. Microbound larval feed as supplement to live food for milkfish**

(*Chanos chanos* Forsskal) larvae. Lavens P, Sorgeloos P, Haspers E, Ollevier F, eds. Larvi '91 - Fish and Crustaceans Larviculture Symposium; Spec. Publ. No. 15; 1991 Aug 27-30; Ghent, Belgium. Ghent, Belgium: European Aquaculture Society; 175-176.

Highly variable results using *Brachionus* as food for milkfish larvae may be related to (1) the relatively low content of highly unsaturated fatty acids (HUFA) in *Brachionus* (Villegas 1989) and (2) inability of first feeding (Day 2) larvae to ingest rotifers in sufficient numbers. Experiments were undertaken to determine whether early supplemental feeding with a microbound diet high in HUFA could improve growth and survival of milkfish larvae.

Milkfish larvae reared in 250L fiberglass tanks at 30 larvae/1 under ambient sea water salinity (32-24 ppt) and temperature (28-30°C) were subjected to the following feeding regime: Day 2-Day 14 - artificial feed (AF) (Nosan-RI, Nosan Kogyo Co. Ltd.), AF + *Brachionus* (AF+Br) or *Brachionus* (Br); Day 15-Day 20 - all tanks were provided only with *Brachionus* and *Artemia* nauplii (3-4 ind/ml) was added beginning Day 18. AF was fed at 100 particles/ml (350 mg/tank) twice daily and *Brachionus* was maintained at 10-15 ind/ml.

Milkfish larvae fed AF+Br were significantly larger than those fed Br when sampled on Day 13 and Day 20. Mass mortalities occurred in AF-tanks on Day 14. Survival of AF+Br larvae was lower (X - 9.02%) than Br larvae (x - 17.7%). A second experiment also showed better growth of milkfish larvae fed AF from first feeding either together with *Brachionus* or given two days before the rotifer. Survival of larvae fed AF+Br in this experiment was also enhanced. Higher survival of larvae initially reared on AF+Br (33%) compared to those reared only on *Brachionus* (6.67%) was also obtained in a test run using 3000 L concrete tanks. Results indicating improved growth of milkfish larvae which may be related to higher levels of HUFA in the supplemental feed will be discussed.

- Millamena OM, Aujero EJ, Borlongan IG. 1990. Techniques on algae harvesting and preservation for use in culture and as larval food. *Aquacult Eng.* 9:295-304.

A method of algae harvesting and preservation was developed. Test algal species consisted of two

diatoms: *Chaetoceros calcitrans* and *Skeletonema costatum*, and two flagellates: *Tetraselmis chuii* and *Isochrysis galbana*. Chemical flocculation using alum and lime were evaluated as methods of harvesting algae. Freezing and sun-drying were used as methods of preservation with viability tests done on frozen samples. The usefulness of sun-dried algae was evaluated through its ability to support survival of *Penaeus monodon* larvae. Results showed that alum and lime flocculation were effective for *Chaetoceros*, *Tetraselmis* and *Skeletonema* but ineffective for *Isochrysis*. Optimum pH for algae removal with alum was found to be 6.5. With lime, algae removals increased with pH and as optimum at pH 9.5. A simple freezing technique preserves the viability of algal concentrates for culture purposes. Good performance of sun-dried *Chaetoceros* and *Tetraselmis* suggests that these algae may be used as larval feed for *Penaeus monodon* alone or supplementarily to eliminate complete dependence on carefully-timed live algal production.

- Parado-Esteva FD. 1991. Survival of newly-hatched larvae of *Epinephelus malabaricus* at different salinity levels. Lavens P, Sorgeloos P, Jaspers E, Ollevier F, eds. Larvi '91 - Fish and Crustaceans Larviculture Symposium; Spec. Publ. No. 15; 1991 Aug 27-30; Ghent Belgium. Ghent, Belgium: European Aquaculture Society; 323-325.

The salinity tolerance of newly-hatched larvae of *Epinephelus malabaricus* was investigated by abrupt transfer from 32 ppt to test levels of 0, 2, 8, 16, 24, 32, 40, and 56 ppt. Mortalities from the start of the test until 96 h were monitored to determine the median lethal time (LT<sub>50</sub>) for the various treatments. Lowest mean LT<sub>50</sub> was obtained at 56 ppt, followed by the mean LT<sub>50</sub>'s at 0 and 48 ppt. Test salinities of 4, 32, and 40 ppt gave similar LT<sub>50</sub> values. However, significantly higher LT<sub>50</sub> values were obtained at 8, 16, and 24 ppt indicating better response of the larvae to these test salinities.

- Parazo MM. 1991. An artificial diet for larval rabbitfish *Siganus guttatus* Bloch. De Silva SS, ed. Fish Nutrition Research in Asia; Proc. 4th Asian Fish Nutrition Workshop; Asian Fish. Soc. Spec Publ. 5; 1990 Sept 3-7; Vijayawada, India.

**Manila, Philippines: Asian Fisheries Society; 43-48.**

A 21-day feeding trial was conducted to determine growth, survival and metamorphosis of larval rabbitfish (*Siganus guttatus* Bloch) fed artificial diets containing approximately 40, 45, 50 and 55% crude protein. *Artemia* nauplii served as the control feed. Larvae performed equally well on all artificial diets with specific growth rate, % metamorphosis and % survival of 7.80-8.35, 95.2-97.9% and 59.9-70.3%, respectively ( $P > 0.01$ ). In contrast, *Artemia*-fed larvae exhibited poor growth (5.03) and low survival (51%) possibly due to inadequate feeding level or poor nutritional quality of *Artemia*. Hence, a diet with 40% protein and estimated energy content of 3,971 kcal  $\text{kg}^{-1}$  may be used with satisfactory results during hatchery production of rabbitfish.

- **Parazo MM, Avila EM, Reyes DM Jr. 1991. Size- and weight-dependent cannibalism in hatchery-bred sea bass (*Lates calcarifer* Bloch). J. Appl. Ichthyol. 7:1-7.**

The relationship of predator size to maximum prey size, and predator weight to weight of prey consumed among cannibalistic seabass (*Lates calcarifer* Bloch) in a hatchery were assessed. Maximum prey size was computed from morphological measurements (predator mouth width, prey body depth and fish total length), while prey consumption was determined from predators kept in experimental beakers and fed only prey sea bass for a 7-day period. Maximum prey size was 61-67% of predator total length ( $TL_{\text{prey}} = 0.5944 TL_{\text{predator}} + 0.0724$ ). Gut dissection of predators showed that size of ingested prey increased with increasing predator size not exceeding the maximum size limit indicated by the above equation. Daily prey consumption of predators in the beakers was expressed as  $W_{\text{prey}} = -0.2407W_{\text{predator}}^2 + 0.7697W_{\text{predator}} - 0.1141$ . During hatchery rearing of sea bass, fish with length differences of more than 33% must be separated and food of appropriate size provided to limit cannibalism.

- **Pascual FP, Sumagaysay NS, Borlongan IG. 1991. Modular method of rearing milkfish with artificial feed. De Silva SS, ed. Fish Nutrition Research in Asia; Proc. 4th Asian Fish Nutrition Workshop; Asian Fish. Soc. Spec. Publ. 5; 1990**

**Sept 3-7; Vijayawada, India. Manila, Philippines: Asian Fisheries Society; 159-167.**

The study was conducted to determine the effectiveness of a practical diet, the profitability of feeding during two seasons, and the effect of a diet with coconut oil on the fatty acid profile of milkfish fingerlings.

Milkfish fingerlings of average weight 6.2 g and 10.2 g were reared in earthen ponds of three compartments (550, 1,100 and 2,200  $\text{m}^2$ ) using the modular culture system. One month prior to harvest, fish in Treatment 1 were fed a practical diet containing 42% crude protein, 13.1% crude fat and 33.2% nitrogen-free extract while fish in Treatment 2 depended solely on the natural food in the pond. The fish fed during the last month of culture were heavier (141 g) than the unfed fish (100 g) in Experiment 1 (dry season) but had similar weights (44 and 41 g) in Experiment 2 (rainy season). Weight gain of fish in Experiment 1 was significantly higher than in Experiment 2. Varying temperature and salinity during different seasons influenced fish growth and production. Feeding milkfish was not profitable during the cooler months. Fatty acid profile in depot fat of fed fish reflected that of the diet. Palatability tests showed that fed fish were preferred to the unfed fish.

- **Piedad-Pascual F. 1990. Polymethylolcarbamide as binder for prawn diets. Fish. Res. J. Philipp. 15:75-79.**

The binding effect of polymethylolcarbamide (PMC) at the levels 0.5% and 1.0% of a practical diet was compared to that of the other binders such as kappa-carrageenan, sodium alginate, carboxymethylcellulose, cornstarch and agar. PMC was found more effective at 0.5% and 1.0% levels as a binder for the formulated practical diet than the other binders used. However, PMC was found ineffective at the same levels, even at 2%, when employed in the semi-purified diet.

- **Quinitio ET, Yamauchi K, Hara A, Fuji A. 1991. Profiles of progesterone- and estradiol-like substances in the hemolymph of female *Pandalus kessleri* during an annual reproductive cycle. Gen. Comp. Endocrinol. 81:343-348.**

The changes in GSI and HSI of *Pandalus kessleri* were monitored during an annual reproductive cycle.

GSI reached a peak when ovaries were composed of yolky oocytes and decreased sharply during the spawning season. HSI followed a similar pattern. The changes in the concentrations of progesterone- and estradiol-17P-like substances in the hemolymph were also investigated. Progesterone levels increased at the onset of vitellogenesis and decreased during vitellogenesis. In contrast, estradiol concentrations rose during the peak of vitellogenesis and dropped after the release of mature eggs from the gonad.

- **Quinitio GF, Toledo JD, Duller AT, Reyes DM Jr. 1991. Survival of yolk-sac larvae of grouper (*Epinephelus suillus*) under simulated transport conditions.** Lavens P, Sorgeloos P, Jaspers E, Ollevier F, eds. Larvi '91 - Fish and Crustaceans Larviculture Symposium; Spec. Publ. No. 15; 1991 Aug 27-30; Ghent, Belgium. Ghent, Belgium: European Aquaculture Society; 326-327.

The survival of 0-day old yolk-sac grouper (*Epinephelus suillus*) larvae at different loading densities during simulated transport were investigated. Loading densities tested were 8000, 16000, 32000, and 64000 ind/l using 10 x 24 cm plastic bags with 100 ml seawater. Each bag was inflated with oxygen at about 1:2, water to gas ratio. The rocking motion of transport was simulated using a laboratory table-top shaker at 100 rpm for 2 h at room temperature. Another set of bags were not subjected to the shaking motion. Results showed that mean survival at 8000-32000 ind/l were not significantly different ( $P > 0.05$ ) in both shaken (75.6-91.4%) and unshaken (65.8-91.3%) bags. However, survival at 64000 ind/l was significantly different ( $P < 0.05$ ) with a range of 7.7-15.2% and 0-0.44% for shaken and unshaken bags, respectively. Water parameters measured in the different treatments were not significantly different ( $P > 0.05$ ).

- **Rokushika S, Kihara K, Yamamoto FM, Subosa PF. 1991. Analysis of nitrite in aqueous solutions containing concentrated matrix ions using an octadecyl-poly(vinyl alcohol) gel microbore column and an electrochemical detector.** J. High Res. Chromatogr. 4:68-70.

This method employs the use of an octadecyl-poly(vinyl alcohol) gel microbore (ODP) column and an electrochemical detector in analyzing nitrite ions in aqueous solutions. Higher retention of nitrite peak

was obtained when concentration of eluent, sulfuric acid was increased. There was no interference from inorganic ions on the ODP column. A minimum height equivalent to a theoretical plate (HETP) value of 20  $\mu\text{m}$  was obtained when a 2.5  $\mu\text{m}$   $\text{H}_2\text{SO}_4$  at a flow rate of 3  $\mu\text{l}/\text{min}$  on a 0.53 x 125 mm column at ambient temperature was used. Nitrite peak was detected at an applied potential of 0.8V vs. Ag/AgCl. At an increasing concentration of an organic modifier, acetonitrile, the peak height of nitrite ion and its HETP increased.

- **Samonte GPB, Agbayani RF, Tumaliuan RE. 1991. Economic feasibility of polyculture of tiger shrimp (*Penaeus monodon*) with Nile tilapia (*Oreochromis niloticus*) in brackishwater ponds.** Asian Fish. Sci. 4335-343.

The polyculture of tiger shrimp (*Penaeus monodon*) with milkfish (*Chanos chanos*) has been practiced in the Philippines, but little is known about the possible polyculture of the shrimp with tilapias in spite of increasing consumer acceptance for tilapias in the country. Shrimp monoculture, two rates of *Oreochromis niloticus* monoculture, and two polyculture treatments were compared for economic feasibility. The stocking combination of 6,000  $\text{ha}^{-1}$  shrimp with 4,000  $\text{ha}^{-1}$  tilapia generated the highest total production and net income with 28357  $\text{kg ha}^{-1}$  and P11,849  $\text{ha}^{-1}$ , respectively. Two crops per year provide a 70% return on investment and 1.2 years pay-back. A sensitivity analysis indicated that shrimp polyculture with tilapia is profitable up to a 20% decrease in the selling price of both species.

- **Santiago AE. 1991. Turbidity and seawater intrusion in Laguna de Bay.** Environ. Monitor. Assess. 16:85-95.

The ecological role of seawater intrusion in Laguna de Bay is assessed due to the operation of the Napindan Hydraulic Control Structure (NHCS). Turbidity is recognized as one limiting factor in the lake's biological productivity. Hence, to stop the natural backflow of seawater to Laguna de Bay removes one important contributory factor in facilitating an early water clearing of Laguna de Bay for a higher annual biological productivity.

- **Santiago CB. 1991. Growth, survival and feed conversion of Nile tilapia fingerlings fed diets containing Bayo-n-ox, a commercial growth promoter. Israeli J. Aquacult. - Bamidgeh 43:77-81.**

A feeding experiment was conducted to determine the effect of a commercial growth promoter, Bayo-n-ox, on Nile tilapia fingerlings (mean initial weight 3.6 g). After 6 weeks, the weight gain of fish given 25 mg Bayo-n-ox/kg body weight was somewhat higher than that of the control fish. A slight growth depression was manifested by fish given 50 mg Bayo-n-ox/kg body weight. Total length followed a trend similar to that of weight gain. However, growth, the feed conversion ratio and the survival rate were not significantly different ( $P>0.05$ ) among treatments.

- **Santiago CB, Camacho AS, Laron MA. 1991. Growth and reproductive performance of bighead carp (*Aristichthys nobilis*) reared with or without feeding in floating cages. Aquaculture 96:109-117.**

Bighead carp (10.5 months old) stocked in cages in Laguna de Bay were assigned the following feeding treatments: (1) 40% protein diet, (2) 20% protein diet, and (3) no artificial diet (control), to determine the effects of feeding on growth and reproduction. The fish were fed for 15 months. Growth was monitored for the first 9 months and fish were induced to spawn in the succeeding months. Both weight gain and increase in total length did not differ significantly ( $P>0.05$ ) among treatments. Results of the induced spawning showed that fish fed the 40% protein diet had the highest mean total weight of eggs/female, total number of eggs/spawning, and number of eggs/kg body weight. Fish fed the 20% protein diet had intermediate values while the control fish had the lowest values for the same parameters. However, mean fertilization rates (54-58%) and hatching rates (61-78%) were not significantly different ( $P>0.05$ ) among treatments. The mean number of 3-day old fry of fish fed the 20% protein diet (48 085) was lower than that of fish fed the 40% protein diet (86 806). The control fish gave a significantly low ( $P<0.05$ ) number of 3-day old fry (37 469). When deprived of food for up to 10 days, fry of the fed broodstock had a lower mortality rate than fry of the control fish.

- **Santiago CB, Laron MA. 1991. Growth response and carcass composition of red tilapia fry fed diets with varying protein levels and protein to energy ratios. De Silva SS, ed. Fish Nutrition Research in Asia; Proc. 4th Asian Fish Nutrition Workshop; Asian Fish. Soc. Spec. Publ. 5; 1990 Sept 3-7; Vijayawada, India. Manila, Philippines: Asian Fisheries Society; 55-62.**

An 8-week feeding experiment was conducted with red tilapia fry of  $0.160\pm 0.035$  g initial weight. Twelve diets of four protein levels (25, 30, 35 and 40%) and three protein to energy (P/E) ratios (111, 100 and 80 mg protein/kcal) at each protein level were used. The highest growth was attained by fry fed a 40% protein diet with a P/E ratio of 111 mg/kcal. A lower but not a significantly different ( $P>0.05$ ) growth response was attained by fry on a 35% protein diet with a P/E ratio of 111 mg/kcal and 30% protein diet with a P/E ratio of 100. Protein efficiency ratio was affected by the dietary protein level. Feed conversion ratio was not significantly influenced by the dietary protein level nor the P/E ratio.

Carcass moisture content (%) was affected only by the P/E ratio. Carcass moisture content was directly related to the P/E ratio of the diets and was inversely related to the digestible energy (DE) level. Both protein level and P/E ratio significantly influenced carcass lipid content (%) on a dry matter basis but not the ash content. Carcass lipid (%) increased with increasing dietary protein and increasing DE levels of the diet, but decreased with increasing P/E ratio. Carcass protein content decreased significantly with the decrease of P/E ratio and increase of DE level of the diet.

- **Santiago CB, Reyes OS. 1991. Optimum dietary protein level for growth of bighead carp (*Aristichthys nobilis*) fry in a static water system. Aquaculture 93:155-166.**

Iso-caloric diets (290 kcal digestible energy/100 g) with protein levels ranging from 20 to 50% in increments of 5% were fed to bighead carp fry ( $3.8\pm 0.2$  mg mean body weight and  $9.8\pm 0.1$  mm total length) for 7 weeks. Growth in weight and length increased as the protein level of the diet increased from 20 to 30% and decreased as the protein level increased further. Although not significantly different ( $P>0.05$ ) from those of fry fed the 25% or 35% protein diet, weight gain (250 mg) and increase in total length



(15.7mm) were highest for fry fed the 30% protein diet. Feed conversion ratio, protein efficiency ratio and survival rate did not clearly indicate the required protein level. The protein requirement was determined using a static-water culture system but assessment of the water quality failed to indicate an association between ammonia concentration and protein in the diet. Further research is necessary to determine why high levels of protein resulted in depressed growth.

- **Subosa PF, Bautista MN. 1991. Influence of stocking density and fertilization regime on growth, survival and gross production of *Penaeus monodon* Fabricius in brackishwater ponds. Israeli J. Aquacult. - Bamidgeh 43:69-76.**

Twelve 0.1 ha earthen ponds were stocked at 3,500 or 7,000/ha with 1-month old nursery reared *Penaeus monodon* Fabricius (1.73 g). Fertilizer treatments were 125 kg chicken manure plus 4.1 kg diammonium phosphate (18-46-0) and 6.56 kg urea (45-0-0) per application for treatments U3500 and U7000 and 125 kg chicken manure plus 8.15 kg diammonium phosphate and 0.89 kg urea per application for treatments P3500 and P7000. Fertilizers were broadcast 10 days after pest eradication and every two weeks thereafter. Water was exchanged (20%) one day before fertilization throughout the 86-day culture period. Shrimp yields at harvest were: P7000, 193.6 kg/ha; P3500, 119.4 kg/ha; U3500, 97.5 kg/ha; and U7000, 82.4 kg/ha. Mean survival for each treatment was 96.2%, 97%, 89.3% and 75%, respectively. There were significant differences in shrimp yields at harvest among treatments ( $P < 0.05$ ).

- **Subosa PF, Bautista MN. 1991. Yield of *Penaeus monodon* Fabricius in brackishwater ponds given different fertilizer combinations. Aquaculture 94:39-48.**

Yields of *Penaeus monodon* Fabricius in brackishwater earthen ponds were determined using different fertilizer combinations in two sets of experiments. Results indicated that the use of fertilizers was vitally needed to sustain growth of shrimps at a stocking density of 5000 individuals/ha. Application of urea (45-0-0) and diammonium phosphate (18-46-0) fertilizers at nitrogen to phosphorus fertilizer rates (N:P<sub>2</sub>O<sub>5</sub> of 15:15 and 30:15 kg/ha, together

with 1 t/ha of chicken manure, was inexpensive and resulted in better yields. In another experiment, increase in the amount of nitrogen and phosphorus fertilizers did not significantly improve prawn yields, but did increase the cost of production. Different salinity levels affected survival in both experiments.

- **Sumagaysay NS, Chiu-Chern YN. 1991. Effects of fiber in supplemental feeds on milkfish (*Chanos chanos* Forsskal) production in brackishwater ponds. Asian Fish. Sci. 4:189-199.**

The study explores the nutritive value of fiber in supplemental feeds for milkfish. The feeding rates were adjusted so that all treatments involved equal protein-N load (6 g kg<sup>-1</sup> fish/day), and varying energy and fiber loads. Rice hull provided the bulk of dietary fiber. Fresh chicken manure, containing 16% protein, served as control. Four 800-m<sup>2</sup> earthen ponds divided into four compartments were used. Milkfish juveniles (29 g) were stocked at 7,000 ha<sup>-1</sup>. After three months of culture, milkfish growth and production and protein efficiency ratio were significantly higher ( $\alpha = 0.05$ ) in fed ponds than in manured ponds. Average yield and manure conversion ratio in manured ponds were 436 kg ha<sup>-1</sup> and 14.5, respectively. There was no significant difference in yields (600-624 kg ha<sup>-1</sup>) between feed treatments. Fish exposed to low protein/33% fiber diet had a worse feed conversion ratio (5.8) than those exposed to high protein/15 or 24% fiber diets (3.6). The results indicate that energy was not limiting in the high fiber (24%) treatment compared to low fiber (15%), but additional fiber (33%) did not further improve growth; and fiber in low protein diets was utilized further as a direct or indirect source of energy. Thus, a low protein/high fiber diet can be an economical way of increasing milkfish production in brackishwater ponds.

- **Sumagaysay NS, Marquez FE, Chiu-Chern YN. 1991. Evaluation of different supplemental feeds for milkfish (*Chanos chanos*) reared in brackishwater ponds. Aquaculture 93:177-189.**

The effects of supplemental feeding on milkfish growth, production, survival, water quality, and economic benefits in brackishwater ponds were reevaluated by comparing a rice bran diet, containing 11.3% protein, and two pelleted diets, containing 22.0% and 27.4% protein, with an unfed control. Four 800-m<sup>2</sup>

tide-fed ponds, subdivided into quarters, were used. Each treatment was replicated in four random pond compartments. Milkfish with initial average weight of 1 g were stocked at 8000/ha and feeding commenced when the average weight and standing crop were 57 g and 417 kg/ha, respectively. All supplemental feeds significantly ( $P < 0.05$ ) increased growth and production over the unfed control. Feeding diets containing 22.0% and 27.4% protein resulted in 35.3% and 46.7% higher net profits, respectively, whereas feeding rice bran resulted in a 34.4% lower net profit when compared to the unfed control. The growth of milkfish became significantly slower ( $P < 0.01$ ) than those fed the 27.4% protein diets when the standing crop of unfed and rice bran-fed fish reached 535 kg/ha and fish fed the 22.0% protein diet reached 972 kg/ha. Survival was not significantly different among the treatments. The concentration of metabolites in the culture water for all treatments was low but a significant increase ( $P < 0.05$ ) in level of total carbon dioxide and nitrite-nitrogen was observed as biomass increased.

- **Tan-Fermin JD. 1991. Effects of unilateral eyestalk ablation on ovarian histology and oocyte size frequency of wild and pond-reared *Penaeus monodon* (Fabricius) broodstock. *Aquaculture* 93:77-86.**

Effects of eyestalk ablation on ovarian maturation of wild and pond-reared *Penaeus monodon* were determined to compare their reproductive potential. This was done by counting the oocyte size frequency in four regions of the ovary and comparing the percentage of each cell type present at each stage of maturation per group. Sampling of ablated prawns was done during three maturation or spawning periods within the first molt cycle after ablation. It took 5 and 14 days for wild and pond-reared prawns, respectively, to show signs of ovarian maturation after ablation. Percentage of proliferating cells, the smallest germinal cells in the prawn ovary, was higher in wild unablated (8.3%) than ablated (2.5-5.0%) groups. Significant differences were observed in all cell types at different stages of maturation. In both unablated and ablated prawns, there was a uniform development of the whole ovary and similar occurrence of atresia at all stages. The presence of bigger oocytes in the ovaries of ablated prawns sampled

after spawning provided histological evidence for lower number of eggs per spawn and faster rematuration.

- **Tan-Fermin JD. 1991. Suitability of different formalin-containing fixatives for the eggs of freshwater Asian catfish *Clarias macrocephalus* (Gunther). *Israeli J. Aquacult. -Bamidgeh* 43:57-61.**

The suitability of different formalin-containing fixatives was tested for the eggs of the catfish (*Clarias macrocephalus* Gunther) by comparing the osmotic pressure of several fixatives with catfish plasma and measuring the size of the eggs at several intervals after fixation. The test solutions consisted of Gilson fluid, 0.5% to 10% buffered formalin, 0.1% to 1% unbuffered formalin with 0.7% sodium chloride (NaCl) and 0.1% to 1% unbuffered formalin with 0.9% NaCl. The osmotic pressure of 1% phosphate-buffered formalin was not significantly different from the catfish plasma, hence it was considered to be the most suitable of all the fixatives tested. Measurement of catfish eggs can be done within 0.5 to 120 hours after fixation in this solution because the rate of swelling (4% to 11% of the size of fresh samples) has been determined. This information is important in induced breeding work of catfish, especially on studies involving the use of egg size.

- **Toledo JD, Kurokura H, Nakagawa H. 1991. Cryopreservation of different strains of euryhaline rotifer *Brachionus plicatilis* embryos. *Nippon Suisan Gakkaishi* 57:1347-1350.**

Cryopreservation of different strains of *Brachionus plicatilis* symmetrical stage embryos was conducted. One S-type strain, namely Yashima-S (YS), and three L-type strains, namely Yashima-L (YL), Nagasaki (NG), and Hamana (HA), were used. Symmetrical stage embryos in 10% DMSO-28% sea water solution were frozen at  $-196^{\circ}\text{C}$  using a two-step freezing procedure; the embryos were first cooled slowly from  $-5^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$  at a rate of  $0.3^{\circ}\text{C}/\text{min}$  and then cooled rapidly by direct transfer to liquid nitrogen. Frozen samples were thawed in a gently stirred water bath at room temperature. A mean survival rate of 36% after 30 days storage in liquid nitrogen of HA strain was significantly lower than YS (55%), YL

(58%), and NG (54%), and is due likely to its relatively larger embryo volume. There was no significant difference in the intrinsic rate of increase ( $r$ ) between strains among clones taken from cryopreservation or unfrozen control group. The results also indicate that various strains of *B. plicatilis* embryos can be cryopreserved without seriously altering their reproductive capability. The freezing method described could be of great potential in aquaculture and in future studies on rotifer genetics.

- **Vetter RD, Bagarinao T. Detoxification and exploitation of hydrogen sulphide by marine organisms. Prior MG, Roth SH, Green FHY, Hubert WC, Reinffenstein R, eds. Proceedings of International Conference on Hydrogen Sulphide Toxicity; 1989 June 18-21; Banff, Alberta, Canada. Canada: The Sulphur Research Network, Univ. of Alberta; 99-116.**

Hydrogen sulfide, one of the toxic gases and occupational hazards in the petroleum industry, is a natural pollutant in the aquatic environment. Sulfide is produced by sulfate-reducing bacteria in sediments that are high in sulfate, rich in organic matter and deficient in oxygen. Marine organisms that routinely encounter sulfide in their habitat have developed various mechanisms of dealing with its toxic effects. Some invertebrates can even actively exploit the energy in sulfide through symbiotic associations with sulfur-oxidizing bacteria. This paper briefly reviews: 1) natural production of sulfide, 2) differences in sulfide toxicity to animals, (3) tools for the study of sulfide metabolism, 4) a conceptual model of sulfide detoxification, and 5) sulfide-based symbiosis. The biochemical mechanisms or adaptations used by these organisms, particularly fish, can give insights into the problems of sulfide toxicity to humans and its management under industrial situations.

- **Villegas CT, Lumasag GL. 1991. Biological evaluation of frozen zooplankton as food for milkfish (*Chanos chanos*) fry. J. Appl. Ichthyol. 7:65-71.**

Milkfish fry with an average standard length and weight of 13.88 mm and 3.95 mg, respectively, were reared for 30 days using live and frozen *Moina macrocopa* and *Brachionus plicatilis* at feeding densities of 10-20 individuals per ml. Growth, survival and yield were used as indicators of the overall perform-

ances of the various treatment groups. Fry fed live *M. macrocopa* showed gains (both length and weight), growth and survival rates and yields significantly higher than fry fed with other treatment groups ( $P < 0.05$ ). However, significant reductions in growth and survival rates resulted when fry were fed frozen *M. macrocopa*. On the other hand, there were no significant differences in growth and survival rates ( $P > 0.05$ ) in fry fed live or frozen *B. plicatilis*.

The results of the current study showed that although milkfish fry could be grown successfully using *B. plicatilis*, feeding with live *Moina* significantly improved growth, survival rate and yield ( $P < 0.05$ ). Frozen *Moina* was found to be unsuitable as feed for rearing milkfish fry because it reduced growth rates and increased mortality. Comparisons between live and frozen rotifers have proven the suitability of frozen rotifers as feed for rearing milkfish fry. By freezing surplus rotifers this would permit short term storage in anticipation of high hatchery demand and overcome any unpredictable failures with live cultures.

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- Stipanuk MH, Coloso RM, Garcia RA, Banks MF. Cysteine concentration regulates cysteine metabolism to glutathione, sulfate and taurine in rat hepatocytes. J. Nutr.
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- Toledo JD, Marte CL, Castillo AR Jr. Spontaneous maturation and spawning of sea bass *lates calcarifer* in floating net cage. J. Appl. Ichthyol.
- Triño A, Penafiorida VD, Bolivar MaE. Growth and survival of *Penaeus monodon* juveniles fed diet without vitamin supplement in a modified extensive culture system. Aquaculture.

# P

## APERS PRESENTED IN SCIENTIFIC MEETINGS

- Agbayani RF, Baliao DD, Samonte GPB, Tumaliuan RT, Caturao RD. 1991. Economic feasibility analysis of the monoculture of mud crab (*Scylla serrata*) Forsskal. 3rd DA-BAR National Research Symposium; 1-2 Aug 1991; Manila.
- Basiao ZU. 1991. SEAFDEC/AQD's research activities and progress in tilapia/carp/catfish research in 1988-1991. ADSEA II; 19-23 Aug 1991; Iloilo City.
- Cheong RM. 1991. Physico-biological criteria for selection of a pilot coastal enhancement center in Panay Island, Philippines. 5th International Conference on Artificial Habitats for Fisheries; 3-7 Nov 1991; Long Beach, California, U.S.A.
- Coloso RM. 1991. Recent advances in milkfish nutrition research. 1991 Annual Convention of the Philippine Biochemical Society; 24 Oct 1991; UP College of Medicine, Manila.
- Cuvin-Aralar MLA. 1991. Progress Report of AGNA Project: Evaluation of resistance of *Oreochromis niloticus* to heavy metal stress. Annual Aquaculture Genetics Network (AGNA) Meeting; 27 Oct - 2 Nov 1991; Chiang Mai, Thailand.
- Duray MN. 1991. Sea bass, grouper, and snapper research at SEAFDEC/AQD in 1988-1991: A review. ADSEA II; 19-23 Aug 1991; Iloilo City.
- Emata AC. 1991. Milkfish, rabbitfish, and mullet studies, 1988-1991: A review. ADSEA II; 19-23 Aug 1991; Iloilo City.
- Gallardo WG. 1991. SEAFDEC/AQD mollusc research activities and progress, 1989-1991. ADSEA II. 19-23 Aug 1991; Iloilo City.
- Golez NV. 1991. The effects of initial process of acid sulfate soil formation in agriculture and aquaculture. 12th Regional Agricultural Research Symposium; 7-8 Mar 1991; Iloilo City.
- Gonzal AC. 1991. Progress report for the project "Broodstock and breeding management of bighead carp, *Aristichthys nobilis*, in hatcheries around Laguna de Bay." Annual Aquaculture Genetics Network in Asia Meeting; 27 Oct -2 Nov 1991; Chiang Mai, Thailand.
- Hurtado-Ponce AQ. 1991. Seaweeds research (1988-1991) at SEAFDEC/AQD: a review. ADSEA II; 19-23 Aug 1991; Iloilo City.
- Hurtado-Ponce AQ. 1991. Vertical rope cultivation of *Gracilaria* (Rhodophyta) using vegetative fragments. 3rd DA-BAR National Research Symposium; 1-2 Aug 1991; Manila.
- Marte CL. 1991. Overview of research activities and accomplishments of the Aquaculture Department. ADSEA II; 19-23 Aug 1991; Iloilo City.
- Millamena OM. 1991. Techniques on algae harvesting and preservation for use in cultures and as larval feed. 3rd DA-BAR National Research Symposium; 1-2 Aug 1991; Manila.
- Parado-Estepa FD. 1991. Recent advances in shrimp research at the Aquaculture Department of SEAFDEC. ADSEA II; 19-23 Aug 1991; Iloilo City.
- Samonte GPB, Agbayani RF. 1991. Pond culture of mud crab (*Scylla serrata*): an economic analysis. Seminar on Mud Crab Culture and Trade; 5-8 Nov 1991; Surat Thani, Thailand.
- Santiago CB, Aldaba MB, Laron MA, Reyes OS. 1991. Reproductive performance and growth of Nile tilapia (*Oreochromis niloticus*) broodstock fed diets containing *Leucaena leucocephala* leaf meal. 3rd DA-BAR National Research Symposium; 1-2 Aug 1991; Manila.
- Villegas CT. 1991. Training and information activities of SEAFDEC/AQD (1988-1991): a performance review. ADSEA II; 19-23 Aug 1991; Iloilo City.

## Research paper awards

Listed below are this year's contribution to the yearly recognition given to SEAFDEC research. The Department began receiving best paper awards in 1987.

3992 *Dr. Elvira O. Tan Memorial Award for Fisheries Research:  
Best Paper in Aquaculture*

Bautista MN, Millamena OM, Kanazawa A. 1989. Use of kappa-carrageenan microbound diet (C-MBD) for *Penaeus monodon* larvae. *Marine Biology* 103:169-174.

*DA-Bureau of Agricultural Research (BAR) National Research Symposium, 1991:  
First Place for Aquaculture Engineering*

Millamena OM, Aujero E, and Borlongan IG. 1990. Techniques on algae harvesting and preservation for use in culture and as larval food. *Aquaculture Engineering* 9(5):295-304.

*DA-BAR National Research Symposium, 1991:  
First Place for Farming Systems*

Hurtado-Ponce AQ. 1990. Vertical rope cultivation of *Gracilaria* (Rhodophyta) using vegetative fragments. *Botanica Marina* 33:477-481.

*DA-BAR National Research Symposium, 1991:  
Second Place for Fisheries and Aquatic Resources*

Santiago CB, Aldaba MB, Laron MA, and Reyes OS. 1988. Reproductive performance and growth of Nile tilapia (*Oreochromis niloticus*) broodstock fed diets containing *Leucaena leucocephala* leaf meal. *Aquaculture* 70:53-61.

*DA-BAR National Research Symposium, 1991:  
Second Place for Socioeconomics*

Agbayani RF, Baliao DD, Samonte GPB, Tumaliuan R, and Caturao RD. 1990. Economic feasibility analysis of the monoculture of mud crab (*Scylla serrata*) Forsskal. *Aquaculture* 91:223-231.

# LINKAGES: Exchange of knowledge and expertise

The Department is cooperating with four non-member governments (Australia, Belgium, Canada, and France), five regional/international organizations or foreign university (Bay of Bengal Programme, International Center for Living Aquatic Resources Management, International Development Research Centre of Canada, International Foundation for Science, and the University of Hohenheim), and four local agencies or university (Department of Agriculture, Philippine Council for Aquatic and Marine Research and Development, University of the Philippines in the Visayas, and UP-Diliman). Collaboration is in research or staff development .

These linkages build not only goodwill but also global exchange of knowledge and expertise.

## **N**ON-MEMBER GOVERNMENTS

### AUSTRALIA

- Staff development

Fellowship grant for a Ph.D in Biological Sciences at the University of Queensland was awarded to G. Javellana, starting 1 Feb.

### BELGIUM

- Research

Egg quality evaluation of *Epinephelus suillus* (Thesis Research); started in Aug 1991.

- Staff development

Ongoing fellowship grants for M.Sc. degree in Marine Ecology at Vrije Universiteit, Brussels for D. Chavez and R. Gapasin.

Ongoing fellowship grant for M.Sc. degree in Environmental Sanitation and Ecology at the State University of Ghent for G. Miñoza.

Training fellowship grant for M.V. Tambasen in the *International Course on Marine Fisheries*, Belgium, 5 Sept to 28 Dec.

### CANADA

- Staff development

Assistantship for Ph.D. in Nutrition at the Canadian Institute of Fisheries Technology, Technical University of Nova Scotia, Halifax, Nova Scotia from 1 Sept 1991 to 31 Aug 1994 for M. Parazo.

### FRANCE

- Staff development

Ongoing fellowship grant for Ph.D. degree at Rennes University for J.M. Almendras.

## **R**EGIONAL/INTERNATIONAL ORGANIZATIONS OR FOREIGN UNIVERSITY

### BAY OF BENGAL PROGRAMME

- Staff Development

Attendance of G. Samonte in the *Regional Seminar on Mud Crab Culture and Trade*, Surat Thani, Thailand, 5-8 Nov.

### INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT (ICLARM)

- Research

Socioeconomic study of oyster (*Crassostrea*

*iredalei*) and mussel (*Perna viridis*) farming in western Visayas; started in Mar 1991.

Economic assessment of the tiger shrimp (*P. monodon*) hatchery industry in Panay Island.

#### INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC) OF CANADA

- Research

*Fish Genetics Project* (3 years: 1989-1992)

(a) Development of a genetically stable reference population of red tilapia; started in June 1990.

(b) Development of a high-yield red tilapia strain through introgressive hybridization; started in Mar 1989.

(c) Practical methodology for genetic strain evaluation of tilapia in small-to-medium sized experimental facilities (Thesis Research); started in Sept 1990.

(d) Evaluation of resistance of *Oreochromis niloticus* strains to heavy metal stress; started in June 1991.

(e) Performance evaluation of two *Oreochromis niloticus* strain in two lake environments; started in Mar 1989.

(f) Broodstock and breeding management of bighead carp, *Aristichthys nobilis*, in hatcheries around Laguna de Bay; started in Feb 1991.

*Seafarming Project* (3 years: 1989-1992)

(a) Resource assessment of selected marine communities in Malalison Island, Antique; started in July 1991.

(b) Economic utilization of resources in Malalison Island, Culasi, Antique; started in July 1991.

(c) An investigation of traditional marine boundaries and territorial use rights in fisheries in Malalison Island; started in July 1991.

(d) Stock assessment of fish populations in Malalison Island, Antique; started in May 1991.

(e) Seaweeds cultivation at Malalison Island, Culasi, Antique; started in Oct 1991.

*Fish Microbiology* (3 years: 1989-1992). Also in collaboration with Simon Fraser University, Burnaby, B.C., Canada.

(a) Investigations on the vertical and horizontal transfer mechanisms of the luminescent bacterium, *Vibrio harveyi*, in *Penaeus monodon* hatch-

eries; started in June 1989.

(b) Parasitology and epidemiology of the epizootic ulcerative syndrome (EUS) positive snakehead, *Ophicephalus striatus*, with notes on the predisposing environmental parameters in Laguna Lake and Lake Naujan; started in Jan 1991.

(c) Histopathology of epizootic ulcerative syndrome in snakehead (*Ophicephalus striatus*) of Laguna de Bay, Philippines (Thesis Research); started in June 1989.

(d) Viral and bacterial etiology of the epizootic ulcerative syndrome (EUS) (Thesis Research); started in June 1989.

- Staff Development

Ongoing fellowship grant for a Ph.D. in Tropical Fish Health at the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia for E. Lacerda until Mar 1992.

Ongoing fellowship grant for a Ph.D. in Fish Genetics at Dalhousie University, Halifax, Canada for Z. Basiao until Aug 1992.

Ongoing fellowship grant for a Ph.D. degree in Biological Sciences at the Simon Fraser University, British Columbia, Canada, for G. Lio-Po until Aug 1992.

Attendance of G. Lio-Po in the *Seminar on Problems on Chemotherapy in Aquaculture*, Paris, France, 12-15 Mar.

Attendance of Z. Basiao in the *4th International Symposium on Genetics in Aquaculture*, Wuhan, China, 29 Apr-3 May.

Attendance of W. Gallardo, G. Samonte, and S. Siar in the *On-farm Session on Rapid Rural Appraisal*, International Institute of Rural Reconstruction, Silang, Cavite, 26-27 Aug.

Attendance of S. Siar in the *Common Property Conference and Workshop*, Winnipeg, Canada, 26 Sept-2 Oct.

Attendance of Z. Basiao, M.L. Cuvin-Aralar, M.R. Eguia, and A. Gonzal in the *Annual Aquaculture Genetics Network in Asia Meeting*, Chiang Mai, Thailand, 26 Oct-2 Nov.

Attendance of F. J. Lacanilao in the *5th International Conference on Artificial Habitats for Fisheries*, California, U.S.A., 2-8 Nov.

Attendance of E. Aralar in the *Pesticides Analysis in the Food and Environmental Samples Training*, University of the Philippines, Quezon City, 4-15 Nov.



Attendance of G. Lio-Po in the *Canadian Society of Microbiologists' 22nd Annual Western Branch Meeting*, Vancouver, Canada, 14-16 Nov; and in the *Nutritional Interrelationships in Aquaculture Symposium*, Vancouver, Canada, 13 Dec.

#### INTERNATIONAL FOUNDATION FOR SCIENCE (IFS)

- Research

Photoperiodic effects on gonadal development of milkfish; started in Sept 1991.

Nutrition and feed development for sea bass: Quantitative essential amino acid and fatty acid requirements of juvenile sea bass, *Lates calcarifer* Bloch; started in July 1991.

Quality assessment of prawn feeds and feed ingredients: Thiobarbituric acid value, urease activity, aflatoxin level, and the biological effects on tiger prawn; started in Mar 1990.

Prevention of *Aeromonas hydrophila* infection among *Chanos charms* (Forsskal) by vaccination; started in June 1989.

- Staff Development

Attendance of M. Bautista in the *USFDA Requirements for Processed Food Training-Seminar*, Cebu City, 11-12 Nov.

Attendance of M. Bautista in the *2nd Congress of the Philippine Prawn Industry '91*, Bacolod City, 21-23 Nov.

Attendance of R. Coloso in the *16th Annual Convention of the Philippine Biochemical Society*, Manila, 24 Oct.

#### UNIVERSITY OF HOHENHEIM, GERMANY

- Research

Energy metabolism of milkfish during starvation and growth (2 years: 1990-1991)

(a) Determination of the maintenance ration of milkfish of varying body size at different rearing temperatures; started in Mar 1990.

(b) Measurement of critical oxygen tension of milkfish at different rearing temperatures and for different body mass groups; started in Mar 1990.

(c) Studies of the oxygen consumption of milkfish with different body mass at different rearing temperatures; started in Mar 1990.

*In vitro* determination of protein digestibility in milkfish (Thesis Research); started in Sept 1990.

# N

#### ATIONAL INSTITUTES/ AGENCIES OR UNIVERSITY

#### DEPARTMENT OF AGRICULTURE-REGION VI

- Research

(1) Development of supplemental diet for milkfish. II. Growth and food consumption during dry and wet season; started in Mar 1991.

(2) Evaluation of CPSP and PROTIBEL as potential protein sources for prawn feeds; started in Apr 1991. Also in collaboration with Cooperative de Traitement des Produits de la Peche (CTTP) of France.

#### PHILIPPINE COUNCIL FOR AQUATIC AND MARINE RESEARCH AND DEVELOPMENT (PCAMRD)

- Staff Development

Ongoing scholarship grant for J. Primavera for a Ph.D. in Marine Biology, U.P. Marine Science Institute, Quezon City, starting Nov 1990.

#### UNIVERSITY OF THE PHILIPPINES IN THE VISAYAS, MIAG-AO (UPV)

- Research

(1) Effects of pH on ammonia toxicity and their influences on survival and growth of the early larval stages of *Penaeus monodon* (Thesis Research); started in May 1991.

- Others

Monthly roundtable discussion on nationally important issues in fisheries/aquaculture attended by UPV faculty and AQD senior research staff; started Oct 1990.

#### UNIVERSITY OF THE PHILIPPINES, DILIMAN

- Research

(1) Influence of some environmental factors on the growth rate and agar quality of selected *Gracilaria* species in Iloilo (Thesis Research); started in Mar 1991.

# SERVICE LABORATORIES: Assistance to fishfarmers

Although the Department's laboratories primarily service research needs, these also provide assistance to fishfarmers and others involved in the aquaculture industry. Except for the Feed Production Laboratory, all laboratories process at a minimal cost samples for analysis. The laboratories are also the venue for practicum and internship trainings.

## FISH HEALTH LABORATORY

A total of 399 diagnostic cases were processed from Jan to Dec. These consisted of 360 (90.2%) shrimp samples, 21 (5.3%) finfish samples, and 18 (4.5%) other samples composed of rearing water from various aquaculture facilities for total bacterial count. The bulk of the cases came from the private sector (93%), while the rest came from AQD-conducted research studies.

## CENTRALIZED ANALYTICAL LABORATORY

Samples analyzed during the period consisted of feed (741), soil (114), and water (3467). Of these, 98 samples of soil (49), water (35), and feed (14) came from the private sector. The rest were from ongoing studies. Analyses done on feeds were for: moisture content, crude protein, crude fat, crude fiber, nitrogen-free extract, ash, calcium, and phosphorus. Water quality analysis involved pH, nitrite-nitrogen, ammonia-nitrogen, phosphate, total alkalinity, dissolved oxygen, total hardness, and turbidity. For soil, the analysis involved pH, organic matter content, available phosphorus, potential acidity, lime requirement, available sulfate, and available iron.

## LARVAL FOOD LABORATORY

Starter cultures of various phytoplankton and zooplankton (408 l) in liquid media and 13 sets of enriched media stock solutions were prepared for the private sector at minimal cost. A total of 23 557 liters of different phytoplankton starters and 21 sets of enriched media stock solutions were provided to different research studies and five training courses conducted at AQD from Jan to Dec. Also, collaborative projects were given 524l of phytoplankton and 88 l of concentrated zooplankton (*Brachionus plicatilis*) starters.

*Artemia* nauplii (953.6 million) and its pre-adult and adult biomass (344 kg) were provided to various research studies. Four different brands of *Artemia* cysts samples were analyzed for hatching efficiency, hatching percentage, and naupliar size.

## MICROTECHNIQUE LABORATORY

A total of 2320 samples were processed. These consisted of liver, gills, kidney, skin, muscles, hepatopancreas, and gonads from various species of finfish, molluscs, and crustaceans. Larval stages of *Penaeus monodon* were likewise processed for serial sectioning. From the above samples, 6410 slides were released to research study leaders for analysis.

## FEED PRODUCTION LABORATORY

The Feed Production Laboratory was built as a service unit of the Feed Development Section. Now fully operational to produce AQD-formulated fish and shrimp feeds, its capacity is 0.5-1.0t/day and will serve the following: (a) laboratory and pond research studies; (b) maintenance and culture of experimental animals; (c) verification studies in collaboration with fishfarmers; and (d) large scale production of AQD-formulated feeds for mariculture and other species.

The feed mill will facilitate production of feed pellets using locally available ingredients, thus helping reduce feed cost component of AQD research studies. Services include feed processing (size reduction which includes sifting, pulverizing, crushing of ingredients; milling; pelletting) and storage.

This feed mill pilot plant was acquired through the Equipment Fund courtesy of the Government of Japan.

## **The researcher, the industry, and research**

There are three points that must be considered when discussing research. These points had arisen in the past years because of the rapid increase in scientific literature and the rapid development of the aquaculture industry.

In Dr. Flor Lacanilao's views, expressed in his welcome remarks in the discussion on 1991 SEAFDEC/AQD research last 28-29 January at Tigbauan, Iloilo, these points are:

- (1) state of scientific literature;
- (2) status of the aquaculture industry;
- (3) environmental consequences of developed technologies.

Knowledge of scientific literature is the responsibility of the researcher. Researcher's ignorance wastes precious resources when work can be done on what is needed by technology end users. Reinvention of the wheel is costly, so to speak.

The aquaculture industry directs research as the latter is presumed to solve problems encountered by farmers. Research must be relevant.

Technologies that can sustain development in the long term must be developed, not those that profit on the short term, often with far reaching environmental consequences. Scientists must take note of their social responsibilities or the social benefits of the technologies that they are developing. An aquaculture practice with a negative impact affects most the already marginalized coastal dwellers.

These guidelines can then redirect research to be pragmatic and socially relevant.



## TRAINING : Development of human resource

Since the establishment of the Department in 1973, it has helped the South-east Asian region develop its human resource for aquaculture. This is through its regular offering of short-term training courses on various aspects of aquaculture that are attended by participants from many parts of the world with majority coming from Southeast Asia.

These courses are 80-90% practical and field work and 10-20% lectures. This "hands-on" approach is complemented by training facilities which include audiovisual rooms, laboratories, fish/shrimp hatcheries, nurseries, and feed mill plant. Lecturers are from the Department's professional research staff of around 62 Ph.D. and masteral degree holders. Faculty from the University of the Philippines in the Visayas and other national and international institutions are also invited.

*Private cooperators are the first to test SEAFDEC/AQD-generated technologies and to integrate them into their operations, ensuring effective transfer of technology.*

### REGULAR TRAINING COURSES

The courses, the dates, countries participating, and the number of trainees are as follows:

<i>Culture of Natural Food Organisms</i>	13 Feb -	Malaysia	2
	13 Mar	Thailand	3
		Philippines	<u>8</u>
			13
<i>Aquaculture Management</i>	20 Mar-	Malaysia	2
	17 Apr	Thailand	2
		Philippines	9
		Sri Lanka	<u>1</u>
			14
<i>Shrimp Hatchery/ Nursery Operations and Management</i>	27 Mar-	Malaysia	2
	14 May	Thailand	3
		Philippines	9
		Sri Lanka	2
		Iran	<u>1</u>
			17
<i>Fish Health Management</i>	24 Apr-	Malaysia	1
	29 May	Thailand	2
		Philippines	<u>11</u>
			14
<i>Marine Finfish Hatchery/Nursery Operations</i>	5 June -	Malaysia	3
	24 July	Thailand	2
		Philippines	11
			16
<i>Fish Nutrition</i>	23 Oct-	Malaysia	3
	5Dec	Thailand	2
		Philippines	6
		Nigeria	<u>1</u>
			12

#### *Culture of Natural Food Organisms*

Among the topics covered in the course were the importance, suitability, and nutritive value of natural food organisms; plankton culture; and *Artemia* utilization in hatcheries.

SEAFDEC provided fellowships to 9 of the 13 participants.

#### *Aquaculture Management*

The 4-wk course aimed to develop the skills of project managers in the areas of aquaculture planning and implementation, monitoring, and evaluation. The course covered technical topics on seed production of finfishes and crustaceans with emphasis on *Penaeus monodon*, grow-out techniques, nutrition, and fish diseases. The management module covered topics on production, marketing, financing, business, and government policies.

Eight of the 14 participants from Member Countries were provided SEAFDEC fellowships.

#### *Shrimp Hatchery/Nursery Operations and Management*

The course aimed to develop skills in operating a small-scale shrimp hatchery including broodstock and nursery with emphasis on *P. monodon*. The course covered topics on site and species selection; design and construction of hatchery and nursery tanks; larval and post-larval rearing and feeding; culture of natural food organisms; harvesting, packing, and transport of fry; and marketing systems.

The important practical activities conducted were eyestalk ablation, broodstock sampling and monitoring, natural food production, larval rearing, feeding and water management, harvesting, and packing.

SEAFDEC provided fellowships to nine of the 17 participants from Member Countries.

#### *Fish Health Management*

The course covered topics on the occurrence and spread of disease in aquaculture operations, microbial diseases affecting aquaculture, non-infectious diseases, and disease prevention and control.

Among the practical activities conducted were bacterial isolation and identification techniques, bacterial count, fungal isolation and identification, histological techniques, bioassay, and health monitoring of shrimp larvae.

Six of the 14 participants were provided SEAFDEC fellowships.

#### *Marine Finfish Hatchery/Nursery*

The course aimed to equip the participants with basic technical skills in operating finfish hatcheries. The course covered topics on seed production techniques of marine finfishes such as sea bass, siganids, milkfish, and grouper; and larval rearing techniques.

Practical activities included hormone injection/implantation, spawning and actual larval rearing activities, egg collection, and mass production of larval food.

Nine of the 16 participants received SEAFDEC fellowship grants.

#### *Fish Nutrition*

The 6-wk course addressed the needs of aquaculture technicians and fish nutritionists for basic theoretical information and skills on aquaculture nutrition. The topics covered were: basic nutrition and feeding theories in determining requirement of cultivable species; formulation and preparation of artificial feeds based on feeding habit/behavior and digestive physiology; and evaluation of feeds with respect to conversion rates, digestibility, and efficiency.

Eight of the 12 participants from Member Countries received SEAFDEC fellowships.

#### *Others*

The scheduled training courses on *Milkfish Hatchery* (17 July-16 Aug), *Sea Bass Hatchery* (14 Aug-13 Sept), and *Shrimp Hatchery/Nursery* (28 Aug-16 Oct) were cancelled due to lack of qualified applicants.

## OTHER TRAINING PROGRAMS

Upon request, internship training may be arranged for individuals and small groups from SEAFDEC Member Countries in chemical / proximate analyses, plankton culture, instrumentation, and other laboratory work. Practicum training is provided for graduating students as part of their requirements for graduation. Summer youth training program is aimed at encouraging out-of-school youth enter the lucrative aquaculture industry.

Participations in these programs (date, country, number of trainees) are as follows:

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<i>Practicum Training</i>	Jan-June	Philippines	48
<i>Internship Training</i>	Jan-June	Philippines	21
<i>Summer Youth Training</i>	Apr -June	Philippines	27

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### *Practicum Training*

Graduating students from four fishery schools availed themselves of the program.

### *Internship Training*

This was in the fields of phycol-ogy, chemical analysis, pathology, economics, microtechnique, and fin-fish hatchery/breeding.

### *Summer Youth Training Program*

Students and out-of-school youth from the Province of Iloilo participated in the program.



# INFORMATION: Extension of technology

Information is a basic component of research and development. It is important in the overall development process because dissemination of research results - as packaged technologies - is essential in bringing about changes in the lives of a research institution's target clientele. For SEAFDEC/AQD, they are the fishfarmers/fisherfolk.

To do this, the Department publishes how-to manuals, leaflets, newsletters, monographs, video tapes, and other print and audiovisual materials. It also participates in fairs and exhibits as well as conducts on-site training. The Department's Library and Documentation Services also cater to the needs of researchers, students, and other interested industry practitioners.

**P**UBLICATIONS AND VIDEO MATERIALS

## MANUAL

*Prawn Hatchery Operations*, AEM No. 19

## LEAFLET

*Identifying Milkfish Fry*, AEL No. 3A (English)

## NEWSLETTERS

*SEAFDEC Asian Aquaculture* (Vol. XII, No. 1-3)

Mar 1991 issue

June 1991 issue

Sept 1991 issue

*Aqua Farm News* (Vol. IV, No. 1-5)

Jan-Feb 1991

Mar-Apr 1991

May-June 1991

July-Aug 1991

Sept-Oct 1991

## INTERNAL NEWSHEET

*Aqua Dep't News* (fortnightly) - 21 issues

## REPORTS

*1990 Annual Report*

*1976-1990 Research Publications*

*Collected Abstracts (1986-1990)*

## MONOGRAPHS

*Biology of Milkfish* by T.U. Bagarinao

*Seaweeds of Panay* by A.H. Ponce et al.

(production ongoing)

## VIDEO MATERIALS

*The AQD Story (10, 20, 30 min)* (production ongoing)

*Getting Down to Sea Bass Tacks* (production ongoing)

*Birthing Sea Bass* (production ongoing)

*Caring for Sea Bass Larvae* (production ongoing)

*Caring for Milkfish Larvae* (production ongoing)

## OTHERS

*Aquaculture Training Program*

*hist of Publications and Video Tapes (June 1991)*

SEAFDEC/AQD Library Acquisitions List

AQD Information Brochure

ADSEA '91 Program and Brochure  
ADSEA II Report  
14th SEAFDEC Program Committee  
Meeting materials  
24th SEAFDEC Council Meeting materials

#### PRESSRELEASES

Fifteen press releases were submitted to SEAFDEC *Newsletter*, dailies, weeklies, and others.

#### JOB REQUESTS

A total of 100 print, graphics, film/slide processing, photo and video coverage, and other requests were serviced.

## E XTENSION ACTIVITIES

SEAFDEC/AQD participated in the *Agri-Food Fair '91 Western Visayas* sponsored by the Department of Agriculture and the National Agricultural and Fishery Council, Iloilo City, 21-24 Feb; in the *Agri-Aqua Industrial Fair* sponsored by the Province of Iloilo, Iloilo City, 4-16 Mar; in *Kaadlawan sang Iloilo*, Iloilo City, 10 Apr; in the *Second DOST Annual Technology Fair*, Philippine Trade Training Center, International Trade Center Complex, Roxas Blvd., Manila, 8-14 July; in the *Second Congress of the Philippine Prawn Industry*, sponsored by the Philippine Federation of Prawn Growers, Inc. and the Province of Negros Occ, Bacolod City, 21-23 Nov; and in the *Regional Technology Fair '91*, sponsored by the Department of Science and Technology, Iloilo City, 13-20 Dec.

SEAFDEC/AQD conducted an outreach seminar on *Fish Nutrition and Feed Development* at the Pasacao School of Fisheries, Camarines Sur, 7-9 June. The seminar was attended by 16 participants.

An on-site training on milkfish hatchery, sponsored by the Department of Agriculture, was conducted by two AQD research staff in Lucap, Alaminos, Pangasinan, 9 Sept-16 Oct. Twelve participants attended.

At the invitation of private cooperators, members of the research staff served as resource persons or gave lectures during meetings and conventions, where they discussed the following topics: *Recent advances in pond preparation for shrimp culture* (Calatrava, Negros Occ, 10-12 Mar); *Shrimp diseases* (Butuan City, 23 Mar); *Shrimp diseases, prevention, and identification* (Roxas City, 11 May); *Soil and water quality management* (Roxas City, 11 May); *Prawn diseases* (Butuan City, 31 Aug); *Shrimp diseases* (Aklan Prawn Hatchery Operators, Kalibo, Aklan, 31 Oct); *Health hazards of fish from manured ponds* (Agri-Kapihan, DYCI-Radyo ng Bayan, Iloilo City, 31 Oct); *Advances in prawn research* (Second Congress of the Philippine Prawn Industry '91, Bacolod City, 21-23 Nov); *Common diseases affecting shrimps and fish, their identification, prevention and control* (Department of Agriculture-Region VI, Iloilo City, 25-27 Nov); and *Milkfish biology* (Agri-Kapihan, DYCI-Radyo ng Bayan, Iloilo City, 10 Dec).

Research staff also served as technical team during meetings convened by the Negros Prawn Producers Marketing Cooperative, Inc. The staff discussed topics related to the problems of the aquaculture industry (Bacolod City, 7 June and 18 July).

## L IBRARY AND DOCUMENTATION SERVICES

Accessioned materials consisted of 458 monographic volumes, 144 pamphlets, 164 bound journals, and 245 SEAFDEC publications. Checklisted were 1845 journal issues (837 from Gifts and Exchanges, and 1008 from paid subscriptions). Also

received from Gifts and Exchanges were 308 monographs, 10 theses, 106 pamphlets, 224 reprints, and 43 brochures and posters. The present library collection stands at 10 158 monographic volumes, 5042 pamphlets, 2359 SEAFDEC publications, and 3634 journal volumes.

A total of 13 018 readers were recorded for 2035 h of library services or an average of about 6 readers per h. Materials borrowed numbered 4828.

Some 485 volumes of books and pamphlets were catalogued and classified. About 1000 journal and other serial titles were inputted in the Serials Data Base, 1646 monographic titles were inputted in the Book Data Base, and about 4000 documents were inputted in the Serial Collection Data Base.

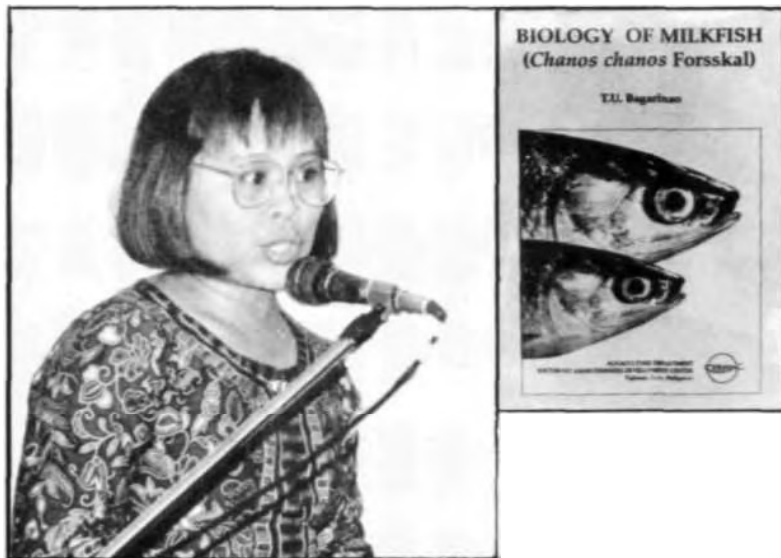
Eighty-five queries from various countries were received and served. These came from researchers, managers/planners, students, documentalists, technicians, and farmers.



## VISITORS

SEAFDEC/AQD received more than 5100 visitors comprising students and teachers from various schools, colleges and universities (93%); government workers (2%); foreign/local scientists and dignitaries (1.4%); and others (3.6%).

## Biology of Milkfish, *Chanos chanos* Forsskal



**Biology of Milkfish (*Chanos chanos* Forsskal)**, AQD's publication by Dr. Teodora U. Bagarinao, was launched 27 Nov 1991 at the Tigbauan Main Station.

The first book launching program held for a Department publication, the affair was considered significant as it was meant to start a tradition for every major AQD publication output.

The 94-page monograph is a comprehensive account of milkfish biology; it discusses species identity and history, geographic distribution and variation, life history and habitat, food and feeding habits, age, growth and mortality, reproduction, behavior, environmental physiology, and community relationships of milkfish in its natural habitat.

It particularly focuses on the ecology of milkfish in Panay Island, where much of milkfish studies were done by SEAFDEC/AQD in 1975-85.



# ADSEA: Direction for aquaculture research and training

As a sequel to ADSEA I held in 1987, the *2nd Seminar-Workshop on Aquaculture Development in Southeast Asia and Prospects for Seafarming and Seafarming* (ADSEA II) was conducted at Iloilo City on 19-23 Aug 1991.

Its objectives:

a. Assess the progress and development of aquaculture, seafarming, and seafarming technologies in SEAFDEC Member Countries;

b. Evaluate the contribution of the Aquaculture Department in the aquaculture development in the region;

c. Identify potential species and priority areas for further research among SEAFDEC Member Countries; and

d. Formulate research and development strategies in seafarming and seafarming for enhancing coastal resources and improving the livelihood of small-scale fisherfolk and fishfarmers.

ADSEA II was sponsored by SEAFDEC and the International Development Research Centre (IDRC) of Canada.

*Research studies are geared to support seafarming and seafarming. hence including small-scale fishermen in the benefits of aquaculture (Photo by K Piamonte, UPV).*

## THE SEMINAR-WORKSHOP

ADSEA II was attended by 26 participants representing Japan, the Philippines, Singapore, and Thailand; cooperating agencies; the private sector; and SEAFDEC/AQD. In addition, 75 observers representing various agencies and institutions, the government and private sectors, and more than 80 SEAFDEC/AQD research and non-technical staff also attended the seminar.

An overview and four country papers on aquaculture development in Southeast Asia and Japan for 1988-1991 were presented. And reviews of AQD research and training activities were also given.

Four simultaneous mini-workshop sessions were conducted on the following commodities: finfishes, crustaceans, molluscs, and seaweeds. The workshops identified the directions for aquaculture research and training during the next three years, from 1992 to 1994.

A special session was held among the representatives of Japan, the Philippines, Singapore, and Thailand. Priority species for study by SEAFDEC/AQD, and the training courses to be offered during 1992-1994, were identified. After the *Seminar-Workshop*, the research areas under each species were also prioritized.

Papers on ecological, social, and economic considerations of seafarming and seafarming were also read. Two reaction papers were presented: (1) the biological point of view summarized unsolved problems that may be addressed by seafarming and seafarming such as overfishing, use of destructive fishing methods, population pressure, lack of alternative employment for the fisherfolk, and habitat destruction; (2) the social science point of view recommended that governments' thrusts should be refocused from fishery development to fishery management, providing equitable access and opportunities to the marine and freshwater resources. As there is good prospect for seafarming and ranching in the region, a good monitoring program should be developed so that resources can be regularly assessed. Also, there should be more government support to fishery scientists who develop the technologies and to the industry that need these technologies through training and extension.

# P

## R I O R I T I E S F O R A Q U A C U L T U R E R E - S E A R C H A N D T R A I N I N G ( 1 9 9 2 - 1 9 9 4 )

### R E S E A R C H

#### I. FINFISH

##### A. MARINE AND BRACKISHWATER

###### 1. Grouper

- a. Inventory and taxonomy
- b. Identification of suitable species for culture
- c. Development of breeding techniques
- d. Broodstock development
- e. Development of rearing techniques for hatchery and nursery
- f. Development of artificial feeds for nursery and grow-out
- g. Induction of sex inversion
- h. Fish health control
- i. \*Others
  - i) International market

###### 2. Milkfish

- a. Refinement of broodstock management
- b. Induction of maturation and spawning by hormonal and photoperiod manipulation
- c. Refinement of hatchery techniques
- d. Verification and economic assessment of hatchery and nursery techniques by private cooperators
- e. Performance of hatchery-produced fry
- f. Bioenergetic and nutrient cycle studies
- g. \*Others
  - i) Factors affecting recruitment and survival
  - ii) Ration and stock assessment
  - iii) Development of practical diets for hatchery, nursery, and grow-out
  - iv) Development of disease prevention and control methods for hatchery, nursery, and grow-out

###### 3. Snapper

- a. Inventory and taxonomy
- b. Identification of suitable species for culture
- c. Development of rearing techniques for hatchery, nursery, and grow-out
- d. Broodstock development
- e. Feed development
- f. Fish health control

###### 4. Sea bass

- a. Induction of off-season spawning by hormonal and photoperiod manipulation
- b. Broodstock management to minimize inbreeding and to control sex inversion
- c. Development of artificial feeds and practical diets
- d. Fish health control
- e. Refinement of rearing techniques in hatchery, nursery, and grow-out
- f. Economics and marketing studies for fry and table-sized fish

###### 5. Rabbitfish

- a. Refinement of hatchery techniques
- b. Refinement of broodstock management
- c. Stock assessment
- d. Viability for searanching
- e. Identification of other species for culture
- f. Socioeconomic assessment of existing industry practices
- g. Market studies
- h. \*Others
  - i) Culture techniques in ponds
  - ii) Development of feeds for hatchery, nursery, and grow-out
  - iii) Diseases in nursery and grow-out

###### 6. Mullet

- a. Inventory and taxonomy
- b. Identification of suitable species for culture
- c. Broodstock development
- d. Development of rearing techniques for hatchery, nursery, and grow-out
- e. Feed development
- f. Fish health control

#### B. FRESHWATER

##### 1. Tilapia (Nile and other species)

- a. Refinement of procedure for strain comparison and evaluation
- b. Selective breeding
- c. Ecological effect of new strains
- d. Improvement of feeding techniques and practices
- e. Development of synchronized spawning techniques in brackishwater
- f. Market studies (international)
- g. Verification of brackishwater and seawater culture techniques

2. Catfish
    - a. Refinement of induced maturation and spawning techniques
    - b. Refinement of hatchery and nursery techniques
    - c. Feed development for nursery and grow-out
  3. Bighead carp
    - a. Refinement of induced spawning techniques
    - b. Feed development for broodstock, nursery, and grow-out
    - c. Genetic improvement
    - d. Fish health control in hatchery, nursery, and grow-out
    - e. Ecological effect
  4. Red tilapia
    - a. Refinement of hatchery management techniques
    - b. Selective breeding
    - c. Feed development
- II. ORNAMENTAL FISHES
1. Marine ornamental fish
    - a. Development of breeding techniques
    - b. \*Others
      - i) Dissemination of culture techniques to fisherfolk
      - ii) International market
  2. Freshwater ornamental fish
    - a. Genetic improvement
- III. CRUSTACEANS
1. *Scyllaserrata*
    - a. Broodstock development
    - b. Development of rearing techniques for hatchery, nursery, and grow-out
    - c. \*Others
      - i) Feed development for grow-out
      - ii) Culture technology verification
      - iii) Postharvest handling technology
      - iv) Abiotic and biotic environmental structures affecting natural production
  2. *Penaeus monodon*
    - a. Restocking of juveniles (and/or adult prawns) in identified sanctuaries
    - b. Comparison of larval performance of fry from wild spawners, ablated and unablated broodstock
  3. Development of a standard set of criteria for fry quality
  - d. Genetic selection
  - e. Fish health control
  - f. Verification and improvement of semi-intensive culture systems (polyculture, modular system, substrates, feeding)
  - g. Ecological effects of intensive shrimp culture practices
  - h. Effect of pesticides and antibiotics on growth and survival
  - i. Establishment of withdrawal periods for antibiotics
  - j. Socioeconomic studies
  - k. Quality assessment of artificial feeds
  3. *Penaeus merguensis*
    - a. Refinement of rearing techniques for grow-out
    - b. Feed development
    - c. Fish health (disease control)
  4. *Penaeus indicus*
    - a. Identification of natural spawning grounds
    - b. Broodstock development
- IV. MOLLUSCS
1. *Crassostrea* sp.
    - a. Resource evaluation
    - b. Site identification
    - c. Depuration
    - d. Spatfall forecasting
    - e. Evaluation of culture technology
    - f. Transplantation
    - g. Refinement of grow-out techniques
    - h. Product development and other uses
  2. *Perna viridis*
    - a. Depuration
    - b. Resource evaluation
    - c. Site identification
    - d. Spatfall forecasting
    - e. Evaluation of culture technology
    - f. Transplantation
    - g. Refinement of grow-out techniques
    - h. Product development and other uses
  3. *Pinctada* sp.
    - a. Site identification
    - b. Resource evaluation
    - c. Seed production
  4. Abalone
    - a. Resource evaluation
    - b. Site identification



- c. Hatchery operation
- d. Development and refinement of grow-out techniques
- 5. *Placuna placenta*
  - a. Spatfall forecasting
  - b. Resource evaluation
  - c. Development of hatchery techniques
  - d. Development of grow-out techniques
  - e. Transplantation
  - f. Site identification
  - g. Product development
- 6. *Placuna sella*
  - a. Spatfall forecasting
  - b. Resource evaluation
  - c. Development of hatchery techniques
  - d. Transplantation
  - e. Site identification
  - f. Development of grow-out techniques
  - g. Product development
- 7. *Tridacna* sp.
  - a. Product development
  - b. Site identification
  - c. Hatchery operation
  - d. Refinement of grow-out techniques
- 8. *Anadara* sp.
  - a. Resource evaluation
  - b. Depuration
  - c. Site identification
  - d. Spatfall forecasting
  - e. Transplantation
  - f. Product development and other uses
  - g. Development of hatchery techniques
  - h. Refinement of grow-out techniques
  - i. Evaluation of culture technology
- 9. *Pholas orientalis*
  - a. Hatchery techniques
  - b. Refinement of grow-out techniques
  - c. Site identification
  - d. Resource evaluation
- 10. Scallops
  - a. Resource evaluation
  - b. Site identification
  - c. Hatchery operation
  - d. Refinement of grow-out hatchery

## V. SEAWEEEDS

- 1. *Eucheuma*
  - a. Development of productive strains - genetic studies

- b. Refinement and economic studies of the raft culture method (vertical and horizontal lines)
- c. Development of efficient seed production technology
- d. Identification of suitable farming areas
- e. Studies on the "ice-ice" phenomenon
- 2. *Gracilaria*
  - a. Inventory of *Gracilaria* species and selection and development of highly productive cultivars with high quality agar
  - b. Development of hatchery technology
  - c. Refinement of production methods
  - d. Genetic studies and creation of seedbank
  - e. Product utilization
  - f. Monoculture and polyculture in ponds
  - g. Socioeconomic studies
- 3. *Gelidiella*
  - a. Resource assessment
  - b. Development of culture techniques
  - c. Product utilization
- 4. *Porphyra*
  - a. Basic biology
  - b. Refinement of culture
  - c. Product utilization
  - d. Screening and characterization of natural products
- 5. *Sargassum*
  - a. Ecophysical studies of wild stocks
  - b. Development of management technology of wild stocks
  - c. Product development and utilization
  - d. Establish market strategy

## TRAINING

### I. TRAINING COURSES

- A. *Fish Nutrition*
- B. *Marine Finfish Hatchery*
- C. *Fish Health Management*
- D. *Aquaculture Management*
- E. *Culture of Natural Food Organisms*
- F. *Shrimp Hatchery*

\*Identified by representative of Japan and/or the Philippines after ADSEA II. Not listed in order of priority.

## **SEAFDEC and fisheries development in Southeast Asia**

Since its establishment in 1967, SEAFDEC has played a significant role in the fisheries development of Southeast Asia. It has offered training on fishing techniques, marine engineering, aquaculture and post-harvest technology to fulfill the requirements of Member Countries. More than 5,000 persons have received training at the Center's Departments. In addition, SEAFDEC held seminars and workshops, which were attended by over 10,000 persons.

SEAFDEC has continuously carried out research on modern fishing technology aimed to improve harvesting by both commercial and small-scale fishermen. It has worked on the improvement of fish handling and postharvest technology with emphasis on optimizing catches for the benefit of domestic consumption and export. It has promoted production of fish and shellfish of high market value through developing and improving aquaculture technology.

SEAFDEC also acts as a focal point for disseminating fisheries information in the region. It has distributed the technology developed directly and indirectly through publications, information and audiovisual programs. To date, SEAFDEC is well recognized as a center for disseminating information on the development of fishing, aquaculture, and fish processing technologies in Southeast Asia. Many countries in the region are now cooperating with SEAFDEC to promote an effective transfer of fisheries information for the benefit of the fishermen and of the country as well.

Although it may not be possible to assess the achievements of SEAFDEC in precise quantitative terms, it is well recognized that SEAFDEC plays a very significant role in fisheries development in the region. The fact that the Center has existed for 24 years is ample testimony.

The Center's prospects are even brighter as its functions expand with the setting up of the Marine Fisheries Resources Development and Management Department in Malaysia, as agreed by the Council in 1990.

- Thiraphan Bhukaswan  
SEAFDEC Secretary General  
July 1991



# ADMINISTRATION and FINANCE: Management of R and D

The essential function of management is to bring an institution's many components together so they can function smoothly, each making an optimal contribution to the R & D organization. Hence, administration and finance not only support research, training, and information by providing basic infrastructure, funds, and people, but, more importantly, they seek to continually upgrade these components.

The Department gives priority to developing its human resource. This is through support of staff attendance in international and national seminars, symposia, and conferences; and degree or non-degree programs and trainings. In addition, physical facilities are being improved, modernized, or even changed to allow employees better productivity tools.

*The Igang Marine Substation has facilities for maturation and spawning of milkfish, grouper, sea bass, and other finfishes in net cages.*

## PERSONNEL

As of 31 December 1991, the permanent staff of AQD totalled 374, with 164 in Research, 37 in Training and Information, 130 in Administration, 22 in Finance, and 21 in the Office of the Chief (see also Appendix).

### STAFF MOVEMENTS

*Recruitments.* Ten fixed-term and one probationary employees were given permanent appointments while four fixed-term and one probationary employees were hired.

*Reappointments.* Twenty-four fixed-term employees were reappointed during the year.

*Resignations.* Ten employees resigned, one employee terminated, while one retired.

### STAFF ACTIVITIES

*Attendance in international seminars, symposia, and conferences*

G. Lio-Po attended the *Seminar on Problems in Chemotherapy in Aquaculture*, Paris, France, 12-15 Mar, sponsored by IDRC.

F. Lacanilao attended the *Seminar on Training Requirements*, Bangkok, Thailand, 23-24 Apr, sponsored by SEAFDEC/TD. V. Sulit attended as Technical Secretary.

Z. Basiao attended the *Fourth International Symposium on Genetics in Aquaculture*, Wuhan, China, 29 Apr-3 May, sponsored by IDRC.

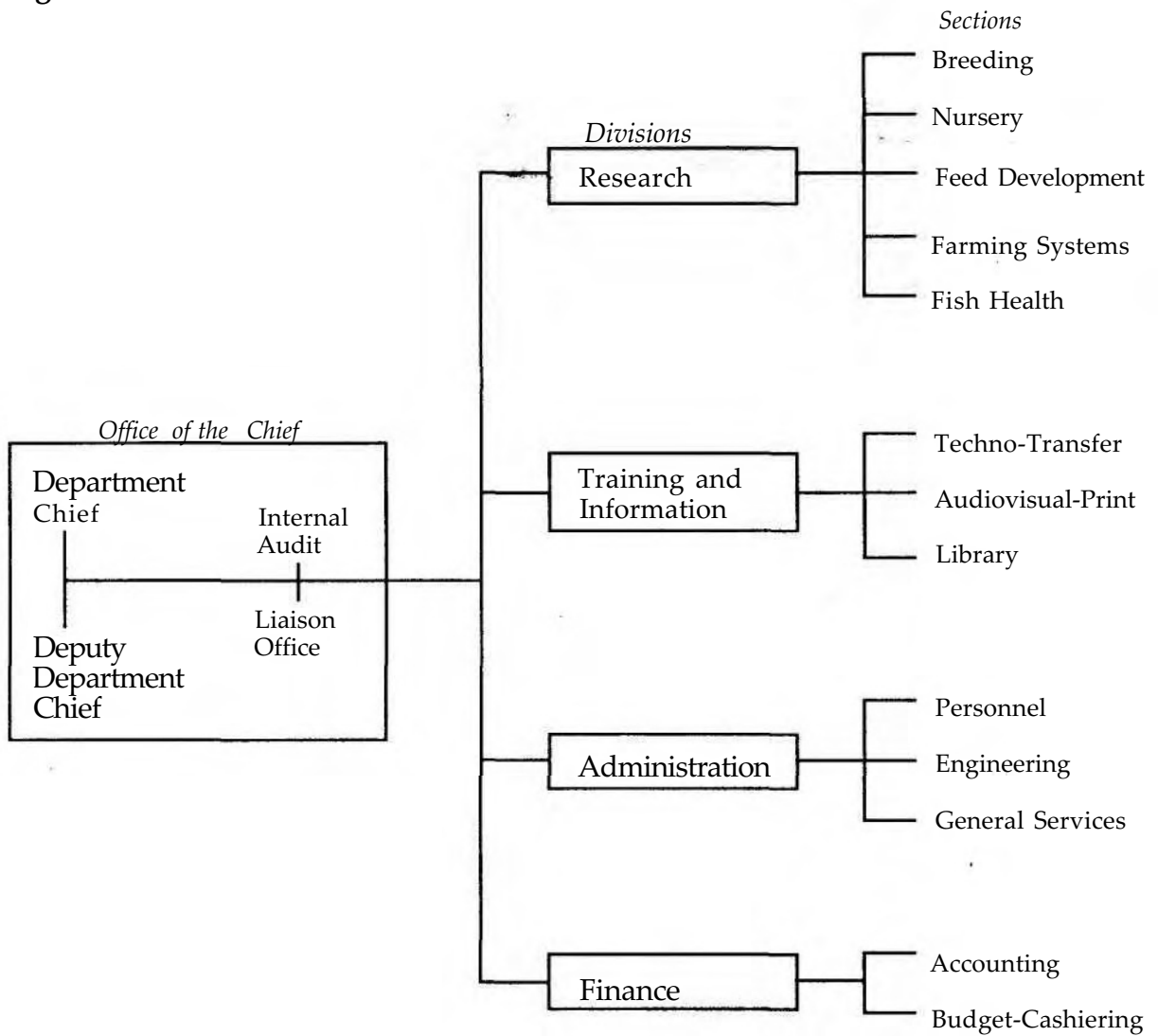
V. Sulit attended the *Second Seminar on Fish Postharvest Technology in Southeast Asia* (1991), Singapore, 6-12 May, as Rapporteur and Technical Secretary, sponsored by SEAFDEC/MFRD.

F. Lacanilao attended, the *Second SEAFDEC Review Committee Meeting*, Bangkok, Thailand, 14-16 May. V. Sulit also attended as Technical Secretary.

Senior research staff and some support staff attended the *Seminar-Workshop on Aquaculture Development in Southeast Asia and Prospects for Seafarming and Searanching* (ADSEA II), Iloilo City, Philippines, 19-23 Aug.

F. Lacanilao, S. Shirahata, C. Marte, and C. Villegas attended the *Fourteenth Meeting of the Program Committee of SEAFDEC*, Metro Manila, Philippines, 24-27 Sept. V. Sulit also attended as Technical Secretary.

**AQD organizational chart**



S. Siar attended the *Common Property Conference and Workshop*, Winnipeg, Canada, 26 Sept-2 Oct, sponsored by IDRC.

F. Lacanilao attended the *Second Workshop on Fisheries Education and Training*, Taipei, Taiwan, 23-29 Oct, and the *Tenth Asian Fisheries Society Meeting*, Taipei, sponsored by the Asian Fisheries Society; and the *Fifth International Conference on Artificial Habitats for Fisheries*, California, U.S.A., 2-8 Nov, sponsored by IDRC.

Z. Basiao, M.R. Eguia, M.L. Cuvin-Aralar, and A. Gonzal attended the *Aquaculture Genetics Network in Asia Meeting*, Chiang Mai, Thailand, 26 Oct-2 Nov, sponsored by IDRC.

G. Lio-Po attended the Canadian Society of Microbiologists' *22nd Annual Western Branch Meeting*, Vancouver, Canada, 14-16 Nov; and the *Nutritional Interrelationships in Aquaculture Symposium*, Vancouver, Canada, 13 Dec, sponsored by IDRC.

F. Lacanilao, S. Shirahata, C. Marte, and C. Villegas attended the *Twenty-Fourth Meeting of the SEAFDEC Council*, Manila, 10-13 Dec. V. Sulit also attended as Technical Secretary.

#### *Attendance in national seminars, symposia, and conferences*

A. Santiago attended the *Seminar-Workshop on Environmentally Sound Management of Laguna Lake Basin*, Los Baños, Laguna, 18-21 Feb, sponsored by the Canadian International Development Agency and the United Nations Center for Research and Development.

N. Golez attended the *12th Regional Agricultural Research Symposium*, Iloilo City, 7-8 Mar; and gave a lecture on pond soil analysis at San Miguel Corporation Technical Convention, Calatrava, Negros Occidental, 12 Mar, sponsored by San Miguel Corporation.

O. Millamena, M. Bautista, V. Peñaflorida, and P. Subosa attended the *Prawn Technical Forum for Prawn Growers in the Visayas and Mindanao*, Bacolod City, 11 Mar.

C. Pitogo gave a lecture on shrimp diseases during the meeting for shrimp farmers sponsored by Clearwater Inc., Butuan City, 23 Mar; during the convention sponsored by Tateh Shrimp Feeds, Butuan City, 31 Aug; and during the Meeting of Aklan Prawn Hatchery Operators, Kalibo, Aklan, 31 Oct.

G. Lio-Po attended the *Seminar on Pollution Aspects of Prawn Farming*, Iloilo City, 27 Apr.

C. Pitogo and N. Golez were resource speakers during the meeting of *Capiz Prawn Growers Association*, Roxas City, 11 May.

C. Pitogo, P. Subosa, and I. Tuburan were resource speakers during the meeting of *Negros Prawn Producers Marketing Corporation, Inc.*, Bacolod City, 7 June.

F. Estepa and P. Subosa composed the technical team during the meeting of *Negros Prawn Producers Marketing Corporation*, Bacolod City, 18 July.

R. Alger, N. Ebron, E. Natividad, J. Coniza, and A. Alagos attended the *Philippine Institute of Certified Public Accountants (PICPA) Symposium on Taxation*, Iloilo City 30 Aug.

M. Duray and S. Padayhag conducted an on-site training on *Milkfish Hatchery* sponsored by the Department of Agriculture in Lucap, Alaminos, Pangasinan, 9 Sept-16 Oct.

S.R. Tillo and Z. Suriaga attended the *39th Annual National Convention of the Philippine Society of Mechanical Engineers*, Iloilo City, 1-19 Oct.

R. Coloso spoke on *Recent Advances in Milkfish Nutrition Research*, 16th Annual Convention of the Philippine Biochemical Society, Manila, 24 Oct.

O. Millamena and C. Pitogo attended the *Annual Convention of the Society of Aquaculture Engineering Practitioners of the Philippines*, Iloilo City, 26 Oct.

R. Agbayani and R. Alger attended the *Second National Convention of the Philippine Association of Research Managers*, Los Baños, Laguna, 28-30 Oct.

E. Lacierda was resource person on *Health Hazards of Fish from Manured Ponds*, Agri-Kapihan, DYCI-Radyo ng Bayan, Iloilo City, 31 Oct.

A. Santiago, M.R. Eguia, A. Gonzal, M. Laron, and R. Eguia attended the *Second National Symposium and Workshop on Tilapia Farming*, Nueva Ecija, 21 Nov.

R. Agbayani, J. Primavera, and C. Pitogo were resource persons during the *Second Congress of the Philippine Prawn Industry '91*, Bacolod City, 21-23 Nov.

C. Marte, O. Millamena, M. Bautista, M. Catacutan, F. Estepa, A. Trino, E. Rodriguez, I. Tuburan, R. Tenedero, and A. Surtida attended the *Second Congress of the Philippine Prawn Industry '91*, Bacolod City, 21-23 Nov.

C. Pitogo and E. Lacierda were resource persons for fish health and discussed common diseases affecting shrimps and fish, their identification, prevention and control, *Department of Agriculture-VI Forum*, Iloilo City, 25-27 Nov.

R. Alger, M. Billena, J. Coniza, and A. Alagos attended the *Annual Convention of the Philippine Institute of Certified Public Accountants*, Bacolod City, 28 Nov-1 Dec.

G. Quinitio and M.T. de Castro attended the *10th Regional Annual Convention of the Pollution Control Association of the Philippines*, Iloilo City, 6-7 Dec.

T. Bagarinao was resource person on *Milkfish Biology*, Agri-Kapihan, DYCI-Radyo ng Bayan, Iloilo City, 10 Dec.

J. Lagoc attended the *Seminar-Workshop on Power of Media*, Iloilo City, 13-14 Dec.

J. Lagoc, M. Castaños, M. Surtida, and A. Surtida attended the *Workshop on Creative Writing*, Miag-ao, Iloilo, 1-5 May.

W. Madjos attended the *Plumber's Workshop*, Iloilo City, 6-8 June.

R. Cuevas and D. Baticados attended the *Area-Wide Seminar on Voluntary Arbitration and Other Voluntary Modes of Labor Disputes Prevention and Settlement*, Iloilo City, 13-14 June.

C. Unggui attended the *Mini Micro CDS/ISIS Training Course*, Pasay City, 17-21 June; the *Annual ISIS Philippine General Assembly*, Metro Manila, 22 June.

R. Agbayani attended the *FAO/SEAFDEC/BIOTROP/Regional Training Course in Fishery Project Formulation*, Bangkok, Thailand, 8 July-3 Aug, sponsored by SEAFDEC/TD.

Twenty-six staff members attended the seminar for *Restricted Radio Telephone Operators*, Tigbauan Main Station, 2 Aug.

W. Gallardo, G. Samonte, and S. Siar attended the *On-farm Session on Rapid Rural Appraisal*, International Institute of Rural Reconstruction, Silang, Cavite, 26-27 Aug, sponsored by IDRC.

M.V. Tambasen attended the *International Course on Marine Fisheries*, Belgium, 5 Sept-28 Dec, sponsored by the Belgian Administration for Development Corporation.

More than 50 research and support staff attended the *Computer Literacy Seminar* sessions, Tigbauan Main Station, 27 Sept-28 Oct.

E. Aralar participated in the training course on *Pesticides Analysis in the Food and Environmental Samples*, Quezon City, 4-15 Nov, sponsored by IDRC.

G. Samonte attended the *Regional Seminar on Mudcrab Culture and Trade*, Surat Thani, Thailand, 5-8 Nov, sponsored by the Bay of Bengal Programme.

M. Bautista attended the *USFDA Requirement for Processed Food Training-Seminar*, Cebu City, 11-12 Nov, sponsored by IFS.

## STAFF DEVELOPMENT

### *Degree Program*

T.U. Bagarinao completed a Ph.D. degree in Marine Biology from the University of California at San Diego, USA, in Oct under the Fulbright-Hays Program.

S. Siar completed an M.Sc. degree in Rural Sociology from the University of the Philippines at Los Baños in Apr; while M.R. Luhan completed an M.Sc. degree in Fisheries (Aquaculture) from the University of the Philippines in the Visayas in June.

G. Javellana is pursuing a Ph.D. degree program in Biological Sciences at the University of Queensland, Australia, starting 1 Feb through a scholarship grant from the Government of Australia.

V. Alava is pursuing a Ph.D. degree program in Marine Nutritional Chemistry at Kagoshima University, Japan, starting 1 Apr through the Government of Japan's Monbusho Scholarship.

N. Guanzon is pursuing an M.Sc. degree program in Agriculture at the Kyoto University, Japan starting 1 Apr, through the Government of Japan's Monbusho Scholarship.

M. Laron is pursuing an M.Sc. degree in Biology at the University of Santo Tomas, Manila.

M. Parazo is pursuing a Ph.D. degree program in Nutrition at the Canadian Institute of Fisheries Technology, Technical University of Nova Scotia, Canada starting 1 Sept.

F. Ayson is pursuing a Ph.D. degree program in Fish Physiology at the University of Tokyo, Japan starting 1 Oct, through the Government of Japan's Monbusho Scholarship.

### *Non-Degree Training*

D. Baticados attended the *Seminar-Workshop on Establishing a Performance Appraisal System*, Metro Manila, 28-29 Jan.

R. Ortega and A. Babol attended the *Seminar-Workshop on Basic Research Methodologies*, Iloilo City, 2-7 Dec.

O. Millamena attended the *Training Course on High Pressure Liquid Chromatography*, Singapore, 4-6 Dec, sponsored by the Instrumix Supplier, Inc. of Singapore.

D. Baticados and B. Benedicto attended the *Seminar-Workshop on Human Resources Planning and Development*, Iloilo City, 4-6 Dec.

## I NFRASTRUCTURE DEVELOPMENT

The following facilities at Tigbauan were completed: (1) renovation of the generator house; (2) installation of additional electrical lines and outlets at the ground floor of the Nutrition Building; (3) renovation of the Feed Laboratory Building; (4) installation of feedmill at the Feed Laboratory Building; (5) repair of indoor hatchery tanks; (6) repair of crustacean hatchery facilities; (7) repair of the Warehouse damaged by typhoon "Ruping"; (8) repainting of roof of the staff houses, partial replacement of the roofing and waterproofing of the concrete gutter of the Apartment Building; (9) installation of freshwater filtration system for the Apartment Building; (10) repair of covered walk columns connecting the field Laboratory and Indoor Hatchery (Phase I); (11) construction of individual roofing of three 150-tons indoor hatchery tanks; (12) relocation of power load center #4; (13), conversion of carpentry shop into supply stock room; (14) construction of researchers' living quarters at Malalison Island, Antique; and (15) the partitioning and levelling of ponds at DA/BFAR site in Iloilo City.

Other ongoing projects at Tigbauan include: (1) construction of one module seawater supply system; (2) reactivation of the air-conditioning exhaust system of the Nutrition Building; (3) structural repair of the Nutrition Building; and (4) repair of roofing of the Research Building.

At Igang, repair of the station house roofing, installation of electrical systems, and fabrication of egg collectors were completed. The development of the experimental ponds which included construction of peripheral dikes and levelling of the fishponds is ongoing.

## F UNDING

The contributions, grants, and other receipts from Jan to Dec, follow:

<i>Contribution</i>	
Philippine Government	\$2,367,149
Government of Japan	427,229
<i>Grants</i>	
IDRC	41,480
IFS	21,641
University of Hohenheim	1,721
ICLARM/AFSSRN	9,874
SEAFDEC Secretariat	30,288
CTPP/Bel Industries	18,734
Showa Denko K.K.	2,700
Cultor, Ltd.	939
<i>Other receipts</i>	157,159
<b>Total</b>	<b>\$3,078,904</b>





# PEOPLE BEHIND THE ORGANIZATION

## MANAGEMENT

Flor Lacanilao, *PhD, Department Chief*  
Satoru Fukumoto, *BS, Deputy Department Chief (outgoing)*  
Soichiro Shirahata, *MS, Deputy Department Chief (incoming)*  
Clarissa Marte, *PhD, Research Division Head*  
Cesar Villegas, *PhD, Training and Information Division Head*  
Rufil Cuevas, *BS, Administration Division Head*  
Rene Alger, *CPA/BS, Finance Division Head*

## FOREIGN EXPERTS/CONSULTANTS

Norio Yasunaga, *PhD, JICA Expert*  
Junji Imayoshi, *MS, JICA Expert*  
Neon Rosell, *PhD, Consultant (Molluscs Prop)*  
Karsten Schroeder, *MS, Visiting Scientist*

## RESEARCH DIVISION

### Tigbauan Main Station

#### Breeding

Luis Ma. Garcia, *MS, Scientist/Section Head*  
Clarissa Marte, *PhD, Scientist*  
Cesar Villegas, *PhD, Scientist*  
Arnul Emata, *PhD, Asso. Scientist*  
Josefa Fermin, *MS, Asso. Scientist*  
Emilia Quintio, *MS, Asso. Scientist*  
Joebert Toledo, *M Sri, Research Asso.*  
Nieves Toledo, *MS, Research Asso.*  
Rose Marie Caballero, *BS, Technical Asst.*  
Grace Garcia, *BS, Technical Asst.*  
Joel Garcia, *BS, Technical Asst.*  
Lillian Gustilo, *BS, Technical Asst.*  
<sup>1</sup>Rolando Gapasin, *BS, Technical Asst.*  
<sup>2</sup>Josephine Nocillado, *BS, Technical Asst.*  
Armando Gamuza, *BS, Research Tech.*

**SEAFDEC staff do not only work to fulfill the institution's mandates but also to help the community where SEAFDEC is situated. Health services and other support are extended to the local community.**

#### Nursery

Gerald Quintio, *D Fish Sci, Asso. Scientist/Section Head*  
Marietta Duray, *MS, Asso. Scientist*  
Armando Fermin, *MS, Asso. Scientist*  
<sup>1</sup>Jesus Almendras, *MS, Research Asso.*  
<sup>1</sup>Felix Ayson, *MS, Research Asso.*  
Fe Dolores Estepa, *MS, Research Asso.*  
<sup>1</sup>Gilda Javellana, *MS, Research Asso.*  
Demetrio Estenor, *MS, Research Asso.*  
Milagros de la Peña, *MS, Research Asso.*  
Ruby Bombeo, *MS, Research Asso.*  
Antonio Castillo Jr, *MS, Research Asso.*  
Emeterio Borlongan, *BS, Technical Asst.*  
<sup>3</sup>Danilo Javellana, *BS, Technical Asst.*  
Corazon Espegadera, *BS, Technical Asst./Actg. Head, Larval Food Lab*  
Eliseo Coniza, *BS, Technical Asst.*  
Deogracias Reyes Jr, *BS, Technical Asst.*  
Edna Bolivar, *BS, Technical Asst.*  
Angelita Tillo, *BS, Technical Asst.*  
Antonietta Duller, *BS, Technical Asst.*  
Daniel Lojera, *BS, Technical Asst.*  
Romulo Ticar, *BS, Technical Asst.*  
Lota Alpasan, *BS, Technical Asst.*

#### Farming Systems

Anicia Ponce, *D Agr, Scientist/Section Head*  
Teodora Bagarinao, *PhD, Scientist*  
<sup>1</sup>Jurgenne Primavera, *MA, Scientist*  
Isidra Tuburan, *MS, Asso. Scientist*  
Renato Agbayani, *MBA, Research Asso.*  
Noel Solis, *MS/MAq, Research Asso.*  
<sup>2</sup>Ronald Cheong, *MS, Research Asso.*  
<sup>2</sup>Neila Sumagaysay, *MS, Research Asso.*  
Edgar Amar, *MAq, Research Asso.*  
Robmar Buensuceso, *MAq, Research Asso.*  
Ma. Teresa de Castro, *MS, Research Asso.*  
<sup>2</sup>Wenresti Gallardo, *MAq, Research Asso.*  
<sup>1</sup>Amalia Gallego, *MS, Research Asso.*  
Jocelyn Ladjá, *MAq, Research Asso.*  
Ma. Rovilla Luhan, *MS, Research Asso.*  
Eduard Rodriguez, *MS, Research Asso.*  
<sup>2</sup>Giselle Samonte, *MMgt, Research Asso.*  
<sup>2</sup>Susana Siar, *MS, Research Asso.*  
Avelino Triño, *MS, Research Asso.*  
<sup>3</sup>Leo Michael Ver, *MS, Research Asso.*  
<sup>1</sup>Nicolas Guanzon, *MEd, Technical Asst.*

Rolando Ortega, *BS, Technical Asst.*  
Ma. Victoria Tambasen, *BS, Technical Asst.*  
Reuel Tumaliuan, *BS, Technical Asst.*  
Jan Sarroza, *BS, Technical Asst.*  
Divina Bermejo, *BS, Technical Asst.*  
Alexander Montes, *BS, Technical Asst.*  
<sup>2</sup>Alessandro Babol, *BS, Technical Asst.*

#### Feed Development

Oseni Millamena, *M Eng, Asso. Scientist/*  
*Section Head*  
Relicardo Coloso, *PhD, Scientist*  
Myrna Bautista, *MS, Asso. Scientist*  
Ilda Borlongan, *MS, Asso. Scientist*  
Mae Catacutan, *M Fish Sci, Asso. Scientist*  
<sup>1</sup>Monina Parazo, *MS, Research Asso.*  
<sup>1</sup>Veronica Alava, *MS, Research Asso.*  
Veronica Peñaflorida, *M Agr, Research Asso.*  
Precilla Subosa, *BS, Research Asso./Head,*  
*Centralized Analytical Laboratory*  
Nelson Golez, *M Agr, Research Asso.*  
<sup>2</sup>Perla Eusebio, *MS, Research Asso.*  
Segundino Solen, *BS, Technical Asst.*  
Lucia Jimenez, *BS, Technical Asst.*  
Ofelia Reyes, *BS, Technical Asst.*  
Analyn Asutilla, *BS, Technical Asst.*  
<sup>2</sup>Florencia Jarder, *BS, Technical Asst.*  
<sup>2</sup>Deograce Murillo, *BS, Technical Asst.*  
<sup>1</sup>May Grace Miñoso, *BS, Technical Asst.*  
<sup>2</sup>Bethany Gumban, *BS, Technical Asst.*  
<sup>2</sup>Emmanuel Penetrante, *BS, Technical Asst.*

#### Fish Health

Celia Pitogo, *MS, Research Asso./Section Head*  
<sup>1</sup>Gilda Po, *M Public Health, Scientist*  
Erlinda Lacierda, *MS, Asso. Scientist*  
<sup>1</sup>Roselyn Fernandez, *MS, Research Asso.*  
<sup>3</sup>Catherine Tamse, *MS, Research Asso.*  
Milagros Paner, *BS, Technical Asst.*  
Susan Torrento, *BS, Technical Asst.*  
Remia Traviña, *BS, Technical Asst.*  
Fely Torreta, *BS, Technical Asst.*  
Eleonor Tendencia, *BS, Technical Asst.*  
Gregoria Erazo, *BS, Technical. Asst./Actg. Head,*  
*Microtechnique Service Lab*  
<sup>2</sup>Eduardo Leño, *BS, Technical Asst.*

#### **Binangonan Freshwater Station**

Alejandro Santiago, *MA, Research Asso./*  
*Station Manager-Research Coordinator*  
Corazon Santiago, *PhD, Scientist*  
Ma. Lourdes Aralar, *MS, Asso. Scientist*  
Zubaida Basiao, *MS, Research Asso.*  
Fermin Palisoc, *MS, Research Asso.*  
<sup>1</sup>Susana Baldia, *MS, Research Asso.*  
Ma. Rowena Eguia, *MS, Research Asso.*  
Angelito Gonzal, *BS, Research Asso.*  
Adelaida Arago, *BS, Technical Asst.*  
Emiliano Aralar, *BS, Technical Asst.*  
Manuel Laron, *BS, Technical Asst.*  
Renato Arcilla, *BS, Technical Asst.*  
Ruel Eguia, *BS, Technical Asst.*

#### **Igang Marine Station**

<sup>3</sup>Albert Gaitan, *BS, Technical Asst.*

#### **TRAINING & INFORMATION DIVISION**

##### Techno-Transfer

Rodrigo Lacierda, *MAq, Research Asso./*  
*Section Head*  
Kaylin Corre, *MS, Research Asso.*  
Jessica Saliente, *MAq, Research Asso.*  
Ruby Salde, *BS, Technical Asst.*  
<sup>1</sup>Denny Chavez, *BS, Technical Asst.*  
Romeo Caturao, *BS, Technical Asst.*  
Rosenio Pagador, *BS, Technical Asst.*  
Rolando Elizon, *BS, Financial Asst.*  
Mildred Rivas, *BS, Financial Asst.*

##### Audiovisual-Print

Julia Lagoc, *AB, Information Asso./*  
*Actg. Section Head*  
Rosita Tenedero, *MA, Information Asso.*  
Augusto Surtida, *BS, Information Asst.*  
Eva Aldon, *AB, Information Asst.*  
Marilyn Surtida, *AB, Information Asst.*  
Milagros Castaños, *BS, Technical Asst.*  
Lydia Plondaya, *BS, Information Asst.*  
Loreto Tabigo-on Jr, *BS, Information Asst.*

### Library and Documentation

Marubeth Ortega, *M Lib Sci, Librarian/Section Head*  
Amelia Arisola, *BS, Information Asst.*  
Luisa Pacino, *BS, Information Asst.*  
Carolina Unggui, *BS, Clerk*  
Alfredo Gustilo, *BS, Clerk*

### **MANAGEMENT SUPPORT GROUP**

#### Office of the Chief

Virgilia Sulit, *MA, Communications Officer/Special  
Asst. to the Chief*  
<sup>2</sup>Eduardo Rondain, *MA, Consultant*  
<sup>2</sup>Ramon Encarnacion, *LLB, Consultant/Legal Counsel*  
Sarah Loma Ortiguero, *BS, Financial Asst. /  
Actg. Adm. Asst.*  
Salve Gotera, *BS, Clerk*

#### Office of the Deputy Chief

Lina Gustilo, *BS, Secretary*

#### Office of the RD Head

Teresita Natividad, *M Lib Sci, Information Asso./  
Data Bank*  
<sup>3</sup>Perla Lopez, *M Lib Sci, Information Asst./Data Bank*  
Leo Cababasay, *BS, Technical Asst./Actg. Adm. Asst.*  
Rufino Macalalag, *BS, Technical Asst./  
Supervisor, Lab. Equipment Maintenance*  
Corazon Cendaña, *BS, Adm. Asst.*  
Larni Angellie Espada, *BS, Technical Asst.*  
Nancy Acdol, *BS, Clerk*

#### Office of the TIP Head

Ma. Anna Josefa Ortiz, *BS, Information Asst./  
Actg. Adm. Asst.*  
Paciencia Garibay, *BS, Secretary*

#### Internal Audit/Systems Group

<sup>2</sup>Manuel Federico Billena, *CPA/BS,  
Executive Officer/Head*  
Teresita Hilado, *BS, Auditing Asst.*  
Merlinda Junio, *BS, Auditing Asst.*  
Renan Saliente, *BS, Auditing Asst.*  
Rolando Mamauag, *BS candidate, Adm. Asst.*

### Liaison Office

Natividad Millar, *BS, Adm. Officer/Head*  
Antonina Duremdes, *BS, Accountant*  
Leticia Mariano, *BS candidate, Financial Asst./  
Actg. Auditing Asst.*  
Ma. Claro Dato, *BS, Financial Asst./Adm. Asst.*  
Estrella Camacho, *BS, Financial Asst.*  
Nerissa Buelo, *BS, Information Asst.*  
Elma Africa, *BS, Property Custodian*  
Florencio Dalusong, *BS, Property Custodian*  
Reynaldo Cabrera, *BS, Clerk*

### Binangonan Freshwater Station

Ma. Luisa Gonzales, *BC, Personnel Asst./  
Actg. Adm. Asst.*  
Romulo Vocalan, *BS, Property Custodian/Purchasing,  
Property and Warehouse*

### Igang Marine Station

Ernesto Torda Jr, *Officer-in-Charge/Actg. Adm. Asst.*

### **ADMINISTRATION DIVISION**

#### Office of the AD Head

Leonardo Tabaldo, *LLB/Asso. in Arts, Adm. Asst.*  
<sup>2</sup>Hector Teodosio, *LLB, Legal Counsel*  
Sylvia San Juan, *BS, Adm. Asst.*  
Tomas Garibay Jr, *BS, Actg. Adm. Asst./  
Iloilo Liaison Office*  
<sup>3</sup>Neri Fernandez, *BS, Property Custodian*  
Offero Templora, *BS candidate, Actg. Security Officer*  
Erlito Langam, *BS, Research Tech./Security and Safety*

#### Engineering

Salvador Rex Tillo, *BS, Section Head*  
Samson Jaspe, *BS, Mechanical & Electrical  
Engineering Supervisor*  
Zaldy Suriaga, *BS, Actg. Water & Aeration  
Engineering Supervisor*  
Mario Jopson, *BS, Engineering Asst./Actg.  
Carpentry Supervisor*  
Jose Edgar Gatton, *BS, Craftsman/Janitorial-in-charge*  
Reynaldo Tenedero, *BS, Engineer*  
Susana Zayco, *BS, Clerk*  
Ramon Soriano, *BS, Clerk*

General Services

Ninfa Calvez, *M Mgt, Adm. Asst./Section Head*

Edwin Parreñas, *BS, Adm. Asst/Housing*

*Management-in-charge*

Gregorio Genzola, *BS candidate, Adm. Asst./Actg*

*Property & Supply Supervisor*

Reynaldo Tuburan, *BS, Property Custodian*

Efren Huervana, *BS, Adm. Asst.*

Leonardo Pineda, *AB, Adm. Asst.*

Juan Bautista, *BS, Clerk*

Augusto Canto, *AB, Clerk*

Rene Loreda, *BS, Clerk*

Personnel

Didi Baticados, *AB/BS, Personnel Supervisor/*

*Section Head*

Norma Teruel, *BS, Personnel Asst.*

Perla Triño, *BS, Personnel Asst.*

Bienvenida Benedicto, *M Mgt, Adm. Asst./Actg.*

*Staff Development & Records Supervisor*

Ma. Antonia Tresvalles, *AB, Personnel Asst.*

Cynthia Animas, *BS, Information Asst.*

Medical Services

<sup>2</sup>Evangeline Tubungan, *MD, Physician*

<sup>2</sup>Therese Hilomen, *DDM, Dentist*

Lorna Rodriguez, *BS, Nurse*

<sup>2</sup>Bernie Golmayo, *BS, Medical Tech.*

**FINANCE DIVISION**

Accounting

Jocelyn Coniza, *CPA/BS, Auditing Asst./Section Head*

Erlinda Natividad, *BS, Accountant*

Nora Tillo, *BS, Financial Asst.*

Evelyn Torres, *BS, Financial Asst.*

Jesus Mansoy, *BS, Financial Asst.*

Amelita Alagos, *CPA/BS, Financial Asst.*

Romulo Taleon, *BS, Financial Asst.*

Joaquin Vera Cruz, *BS, Financial Asst.*

Cashiering-Budget

Nelda Ebron, *BS, Accountant/Section Head*

Juan Garin Jr, *BS, Accountant/Head, Cashiering*

Lucena Mallo, *BS, Financial Asst./Actg. Accounting*

*& Budget-in-charge*

Arden Tillo, *BS, Financial Asst.*

Ester Cang, *BS, Financial Asst.*

Rosario Torred, *BS, Financial Asst.*

Yolanda Gepulla, *BS, Financial Asst.*

Levy Jean Hilado, *BS, Financial Asst.*

David Grio Jr, *BS, Financial Asst.*

<sup>1</sup> On study leave.

<sup>2</sup> Contractual.

<sup>3</sup> On leave.

Better Life Through Aquaculture:  
1991 Report of SEAFDEC  
Aquaculture Department  
April 1992



On the cover

The present (front) and future (back) fishermen of Malalison Island in Antique are the ultimate beneficiaries of the Department's seafarming and searanching project. (Photos by I. Tendencia)